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**EBASCO**

ARCS II PROGRAM

Remedial Planning Activities at Selected
Uncontrolled Hazardous Substance
Disposal Sites Within EPA Region II
(NY, NJ, PR, VI)

EPA Contract 68-W8-0110

EBASCO SERVICES INCORPORATED

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EPA WORK ASSIGNMENT NUMBER: 012-2PX3
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EBASCO SERVICES INCORPORATED

ARCS II CONTRACT

FINAL
ENDANGERMENT ASSESSMENT
RI/FS OVERSIGHT
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

JULY 1990

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July 27, 1990
ARCS II-90-283

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SUBJECT: HOOKER/RUCO RI/FS OVERSIGHT
HICKSVILLE, NEW YORK
WORK ASSIGNMENT NUMBER 012-2PX3
EPA CONTRACT NUMBER 68-W8-0110
FINAL ENDANGERMENT ASSESSMENT

Dear Mr. Alvi and Mr. Tomchuk:

Ebasco is pleased to submit this Final Endangerment Assessment Report for the Hooker/Ruco RI/FS Oversight Work Assignment. Comments on the Draft Endangerment Assessment Report by USEPA and other agencies have been incorporated in this Final Report.

Please return the acknowledgement of receipt form attached to this letter and if you have any questions regarding this submittal, please feel free to call the site manager, Mr. K. Subburamu at (201) 460-6028.

Sincerely yours,

Dev R. Sachdev

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July 27, 1990
ARCS II-90-283

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SUBJECT: HOOKER/RUCO RI/FS OVERSIGHT
HICKSVILLE, NEW YORK
WORK ASSIGNMENT NUMBER 012-2PX3
EPA CONTRACT NUMBER 68-W8-0110
FINAL ENDANGERMENT ASSESSMENT

ACKNOWLEDGEMENT OF RECEIPT

Please acknowledge receipt of this final Endangerment Assessment on the duplicate copy of this letter and return it to the sender at the above address. Thank you.

Signature

Date

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EPA WORK ASSIGNMENT NUMBER: 012-2PX3
EPA CONTRACT NUMBER: 68-W8-0110
EBASCO SERVICES INCORPORATED

FINAL
ENDANGERMENT ASSESSMENT
RI/FS OVERSIGHT
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

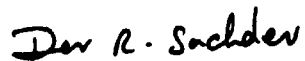
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EXECUTIVE SUMMARY

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HOOKER/RUCO SITE
ENDANGERMENT ASSESSMENT

EXECUTIVE SUMMARY

In October 1984, the United States Environmental Protection Agency (USEPA) placed the Hooker Chemical/Ruco Polymer Corporation site (Hooker/Ruco) located in Hicksville, New York on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program. The site is currently classified as an enforcement lead site for which potentially responsible parties (PRPs) are conducting a Remedial Investigation/Feasibility Study (RI/FS). The PRPs for the site have retained the consulting firm Leggette, Brashears and Graham, Inc. (LBG) to perform a detailed RI/FS.

This endangerment assessment (EA) of the polychlorinated biphenyl (PCB) spill area soils surrounding the Pilot Plant on the Hooker/Ruco site was prepared at the request of Region II of the USEPA under the ARCS II Superfund Contract. It has been conducted independently of the PRP's efforts, but relies on the LBG RI report (April, 1990) and Focused Feasibility Study (FFS) (November, 1989) as the primary sources of information concerning conditions at the site. In addition, it is the intent of this EA to address the potential human health and environmental impacts associated with the Hooker/Ruco site under the no-action alternative, that is, in absence of remedial (corrective) action as required under Section 3008 (f)(v) of the National Contingency Plan.

Aroclor-1248 was selected by USEPA Region II to be the solitary contaminant of concern. Upon this determination, the environmental fate and transport of this chemical was then considered to assist in the evaluation and quantification of human health risks. Based on a generic screening level model Aroclor-1248 was calculated to be relatively immobile.

For the quantitative assessment of risks, exposure estimates were combined with the health criteria for the selected chemicals of potential concern to estimate potential risks to human health. For exposure, risks are estimated for an average and a reasonable maximum exposure (RME) scenario. The average case combines the average case exposure estimated with generally upper-bound cancer potency factors and conservatively derived reference doses. This average case is intended to represent the exposure of a typical individual; however, use of conservative health criteria may result in an overestimation of risk even for the average case. The RME scenario combines the reasonable maximum exposure estimates to represent a conservative upper bound on the potential risks. Although this worst-case scenario possibly can occur, the likelihood is extremely small due to the unlikely combination of many conservative assumptions used.

Three exposure pathways were evaluated under the present and future-use scenarios. These exposure pathways are as follows:

- o Ingestion of surface and subsurface soil
- o Direct contact with surface and subsurface soil
- o Inhalation of suspended site soil

A target risk level of 10^{-6} , established by USEPA (USEPA, 1989a) was exceeded under all exposure scenarios, the highest risk being exhibited by site workers. For the inhalation of suspended site soil pathway, chronic daily intakes were determined in the absence of inhalation cancer slope factors to assess the body intake via inhalation. When contrasted against ingestion and direct contact, inhalation intake ranged from 4.6% to 10% of the total contaminant intake for the site worker and trespasses scenario.

Using the RME exposure pathway for site workers, a risk based cleanup level of 0.37 ppm was calculated. At the request of Region II of the USEPA, risk levels for the cleanup goals of 2 ppm, 10 ppm, and 25 ppm were determined. Using the RME site workers calculation the following risk levels were obtained.

<u>Cleanup Goal</u>	<u>Risk Level</u>
2 ppm	5.4×10^6
10 ppm	2.7×10^{-5}
25 ppm	6.8×10^{-5}

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SECTION 1.0

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1.0 INTRODUCTION

1.1 OVERVIEW

In October 1984, the United States Environmental Protection Agency (USEPA) placed the Hooker Chemical/Ruco Polymer Corporation site (Hooker/Ruco) located in Hicksville, New York on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program. The site is currently classified as an enforcement lead site for which potentially responsible parties (PRPs) are conducting a Remedial Investigation/Feasibility Study (RI/FS). The PRPs for the site have retained the consulting firm Leggette, Brashears and Graham, Inc. (LBG) to perform a detailed RI/FS.

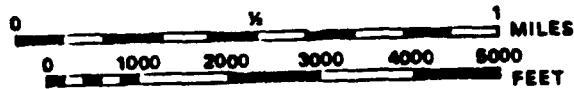
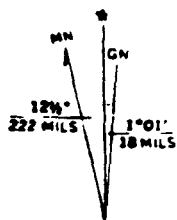
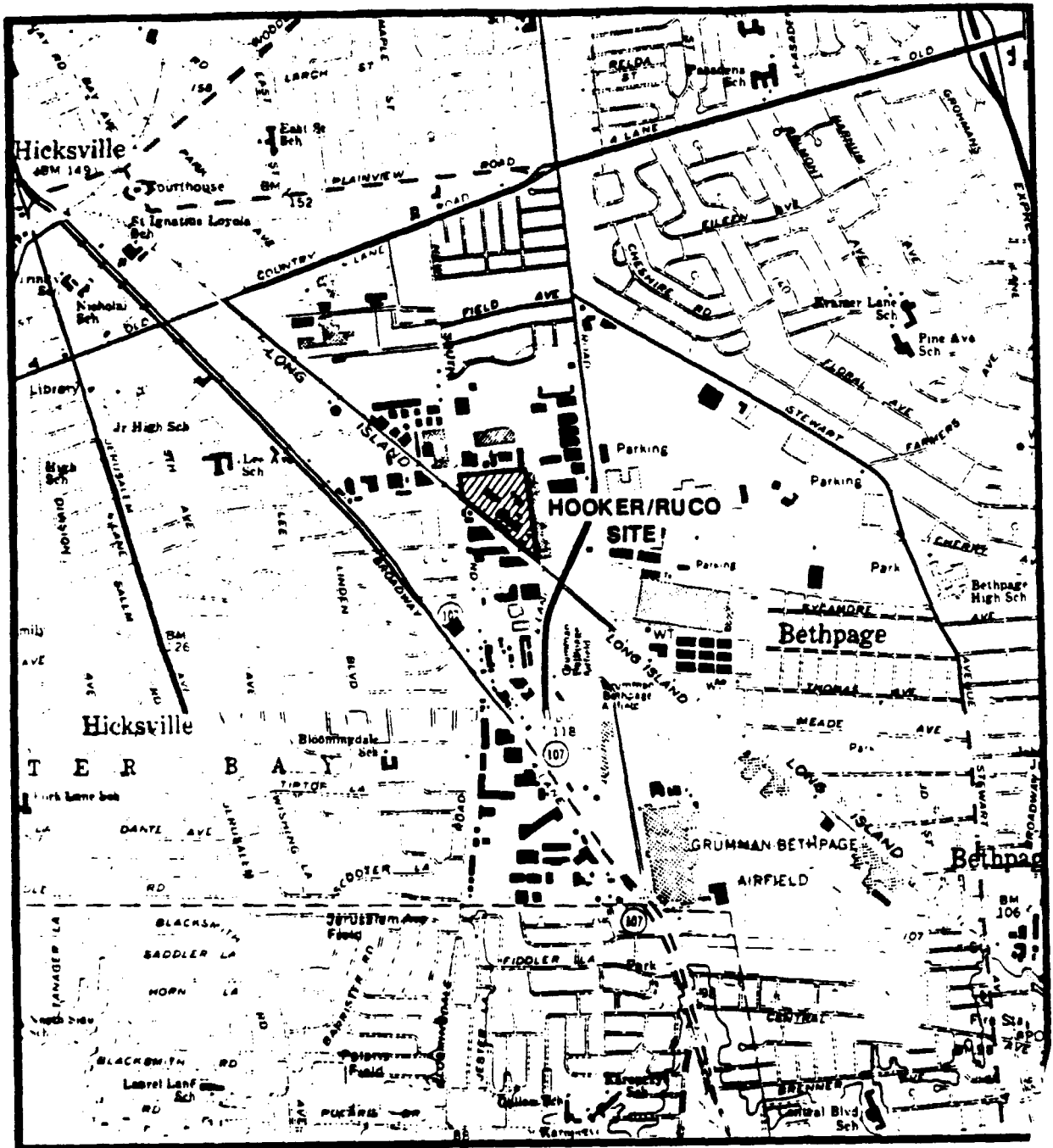
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1.2 SITE BACKGROUND

1.2.1 Site Description

The Hooker/Ruco site is an active chemical manufacturing facility located in a heavily industrialized section of the city of Hicksville, Nassau County, Long Island, New York. The facility, currently owned and operated by the Ruco Polymer Corporation, contains four buildings for the manufacture and storage of chemical products (Plants 1, 2, 3 and the Pilot Plant) and an administration building. The remainder of the 14-acre site contains parking areas, chemical storage tanks, recharge basins and small ancillary structures. The facility currently employs 96 personnel and manufactures polyester, polyols and powder coating resins. A general site location map is displayed in Figure 1-1, while Figure 1-2 displays current plant conditions.

The study area surrounding the Hooker/Ruco site is comprised of an industrialized corridor and residential complexes. The nearest major industrial facility to the site is the Grumman Aerospace Corporation Bethpage manufacturing facility and



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HOOKE/RUCO SITE

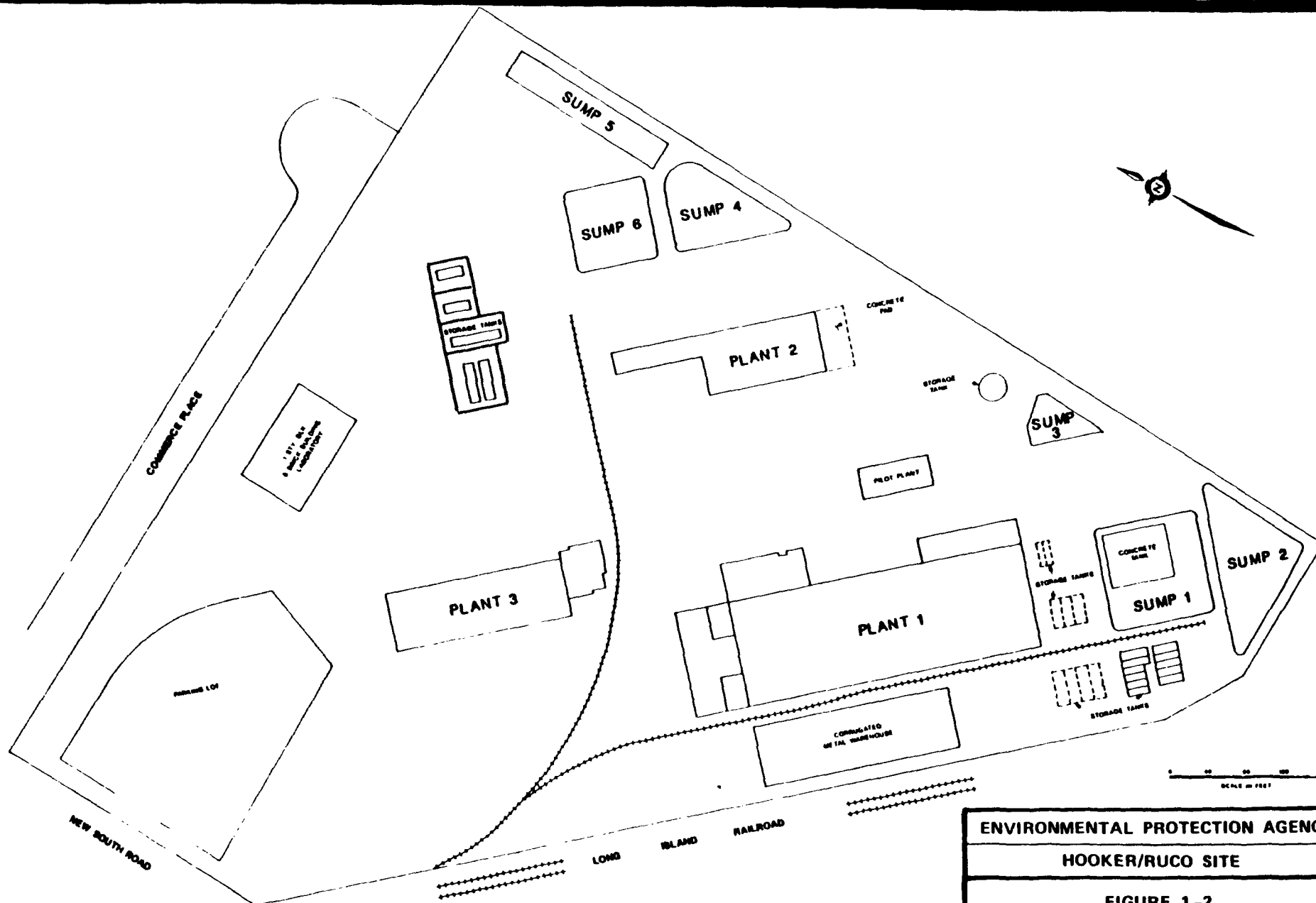
FIGURE 1-1

SITE LOCATION MAP

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* ADAPTED FROM U.S.S. AMITYVILLE, FREEPORT, HUNTINGTON AND HICKSVILLE, NY, QUADRANGLE'S, PHOTOREVISED 1979.

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ENVIRONMENTAL PROTECTION AGENCY
HOOKER/RUCO SITE
FIGURE 1-2
SITE FEATURES
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airport which borders the site to the south and east. There are many other small industries, commercial operations, utilities, transportation corridors and stormwater management basins also in the study area. Residential dwellings comprise approximately 25 percent of the study area and are located southwest of the site. Approximately 5 percent of the study area is undeveloped. Further site details are discussed in Section 3.1, Characterization of Exposure Setting.

1.2.2 Site History

Presented below is a brief summation of past activities which have occurred at the Hooker/Ruco site. All information has been extracted from the September 28, 1988 response by Occidental Chemical Corporation (OCC) to a CERCLA 104 request for information. A fully comprehensive review of the site history may be found in the LBG RI report (April, 1990).

The area of interest was originally developed by the Rubber Corporation of America, a small privately-held company. Operations at the site began in 1945 and included natural rubber latex storage, concentrating and compounding. Five years later, the plant began producing small volumes of plasticizers. In 1956, a polyvinyl chloride plant was built, and was initially operated under the name Insular Chemical Corporation. This plant continued in operation until 1975. Hooker Chemical Company (Corporation) purchased Rubber Corporation of America in 1965, and operated the facility as the Ruco Division. Hooker has undergone several name changes, with the current name being Occidental Chemical Company (Corporation). The site was sold to employees in February 1982. Thus Occidental Chemical Company or the Rubber Corporation of America owned and operated the site between 1945 and 1982. The site is now operated by a privately held corporation under the name Ruco Chemical Corporation which is not affiliated with OCC. OCC did not lease any portion of the site to third parties, however an office building for the facility was leased north of the site.

PVC (polyvinyl chloride) was a key material in the products made at the site. Prior to 1955 this material was purchased from outside sources. During the period 1956 to 1975, polyvinyl chloride was then produced at the site. Through the years in which OCC operated the site, various additional processes were employed including the manufacture of polyesters, polyurethanes, and specialty plasticizers for the vinyl industry. Other products included vinyl film and sheeting, solution polyurethanes and polyurethane latexes, dry blends and pelletized plastic compounds. Activities in the Pilot Plant involved the production of polyester, plasticizer and polyurethane products, and the laboratory was utilized for organic chemical synthesis and technical service.

Prior to 1987, periodic discharges of PCB Therminol had occurred adjacent to the Pilot Plant and had reportedly affected an area about six feet square. Subsequent investigations revealed that, while only a relatively small area has been affected below the surface soils, PCBs have been spread over a larger area. This is presumably a result of surface-water runoff, sediment transport and truck traffic. The PCBs, comprised primarily of Aroclor-1248, have migrated along a ditch and into a storm-water recharge basin and were present in soils excavated during a tank removal program adjacent to the Pilot Plant undertaken by Ruco. The extent of the occurrence has been identified through soil sampling and analysis conducted in phases from June 1983 to September 1988 by LBG.

1.3 SCOPE OF ENDANGERMENT ASSESSMENT

The focus of this endangerment assessment is the human health and environmental hazard posed by the Hooker/Ruco site PCB spill area soils only. Public health evaluation methodology used in this study involved several steps. The first step involved the determination of the chemical contaminants of concern in the various media at the Hooker/Ruco site. For this site, PCBs (Aroclor-1248) have been designated by the USEPA Region II as the solitary contaminant of concern. After the designation of the contaminant of concern, the second step defined the potential human exposure pathways specific to the Hooker/Ruco site. Each potential exposure pathway was assessed for inclusion or exclusion in the public health evaluation. The area demography and land use characteristics (Section 3.1.2) were all taken into consideration when the pathways were evaluated in this endangerment assessment. The features taken into account included, but were not limited to: land use in the immediate vicinity of the Hooker/Ruco site, area residential population, distance to nearest residential areas and the presence of any agricultural areas.

The following step in the public health evaluation methodology involves a quantitative assessment of each potential exposure pathway. For noncarcinogens, exposure pathways were evaluated by comparing site-specific intake (SI) rates of indicator contaminants with acceptable intake rates, based on available toxicological, chemical and physical characteristics of the contaminants of concern. Exposure pathway and matrix-specific intake rates for these chemicals were calculated utilizing pathway modeling. The acceptable intake rates were then compared to the actual matrix-specific intake rates to initially determine if a potential human health risk may exist.

Potential risks for noncarcinogens are characterized using the ratio of Chronic Daily Intake (CDI) to the Reference Dose (RfD). The sum of all of the CDI:RfD ratios for the selected chemicals of concern is identified as the Hazard Index, and is shown below:

$$HI = \text{Sum} \left(\frac{CDI_i}{RfD_i} \right)$$

where

HI = Hazard index,

CDI_i = Chronic daily intake for chemical i (mg/kg/day),
and;

RfD_i = Reference dose for chemical i (mg/kg/day).

A hazard index less than one is unlikely to be associated with health risks and is therefore less likely to be of concern than a hazard index greater than one. A conclusion should not be categorically drawn, however, that all hazard indices less than one are "acceptable" and all HIs greater than 1.0 indicate that health risks will occur. This is a consequence of the uncertainties inherent in the derivation of the RfD in the exposure assessment, and the uncertainties associated with adding the individual terms in the hazard index calculation (as will be discussed in the uncertainty section).

Potential for excess lifetime cancer risk is calculated by multiplying the CDI by the cancer slope factor as follows:

$$\text{Excess lifetime cancer risk} = CDI \times q_1^*$$

where

CDI = Chronic daily intake of chemical (mg/kg/day), and;

q₁* = Cancer slope factor for chemical (mg/kg/day)⁻¹.

This linear equation is valid for excess lifetime cancer risks less than 10⁻² (one in one hundred). Above this level, individual excess lifetime cancer risks would be calculated using the equation:

$$\text{Excess lifetime cancer risk} = 1 - \exp(-CDI \times q_1^*)$$

In accordance with USEPA's guidelines for evaluating the potential toxicity of chemical mixtures (USEPA, 1989a) and in the absence of specific information on the toxicity of the mixture to be assessed or on similar mixtures, it will be assumed that the effects of the chemicals of concern would be additive. Synergistic or antagonistic interactions may be taken into account if there is specific information on particular combinations of chemicals. In this EA, where there is only one contaminant of concern, this standard assumption has no bearing. However, lifetime excess cancer risks and the SI:RfD ratios will be summed across each pathway to indicate the potential risks associated with different exposure to potential carcinogens and noncarcinogens, respectively.

It should be noted that this endangerment assessment has been conducted using generally conservative assumptions according to the risk assessment guidelines outlined by USEPA (1989a) which supersedes those specified in The Endangerment Assessment Handbook (USEPA, 1985). The purpose of using conservative assumptions is to explore the potential for adverse health effects using conditions that tend to overestimate risk so that the final estimates will usually be near to or higher than the upper end of the range of actual exposures and risks. As a result, this endangerment assessment should not be construed as presenting absolute estimates of risk to human health or the environment. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts to occur.

1.4 ORGANIZATION OF ENDANGERMENT ASSESSMENT REPORT

The presentation of this EA has followed the format outlined in Risk Assessment Guidance For Superfund: Human Health Evaluation Manual, Part A (USEPA, 1989a). Beginning with Section 2, chemicals of concern considered most likely to pose risks to human health are identified for each environmental medium sampled. In Section 3, Exposure Assessment, the migration potential of the selected chemicals of concern is evaluated through examination of site environmental factors, waste characteristics and physical and chemical properties of the selected chemicals. Subsequently, potential exposure pathways under current and hypothetical future site use conditions are identified and concentrations of the chemicals of concern at potential exposure points are estimated. In Section 4, the Toxicity Assessment, the health criteria (i.e., dose-response) values used in the quantitative estimation of potential health risks are identified. In addition, the range of potential health effects for each of the chemicals of concern is briefly reviewed. In Section 5, the estimated exposure point concentrations given in Section 3 are compared to applicable or relevant and appropriate requirements (ARARs) where they exist for the chemicals of concern. Then, for each identified exposure pathway which will be quantitatively evaluated, potential chemical intakes are estimated and combined with the health criteria values to predict potential human risks. Section 6 presents a discussion of the uncertainties associated with the EA. Section 7 concludes this report with a Summary and conclusions of the assessment.

SECTION 2.0

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2.0 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

2.0.1 Data Collection Activities

All pertinent information regarding data collection activities for the PCB spill area soils may be found in the LBG RI (April, 1990) and FFS (June, 1990) reports. Data evaluated in this EA has been extracted from Plate 2 of the FFS, Analytical Results of Samples Obtained from Excavated Soils (LBG, 1988) and Volume 5 of the RI at the request of Region II of the USEPA and a tabulation is provided in Appendix A. The results of sampling performed during these programs are summarized in this section.

2.0.1.1 Soil Data

Soil samples were collected for analysis at 92 locations in the PCB spill area surrounding the Pilot Plant. Surface soil samples were collected from 0 to 3 feet in depth at all but one location, while subsurface soil samples were collected at depths below 3 feet at 17 locations. All soil samples were analyzed for Aroclor-1248 with the exception of those collected during the RI activities, which were also analyzed for the remaining Target Compound List/Target Analyte List (TCL/TAL) compounds. Although concentrations of these parameters have been detected, Region II of the USEPA has requested that they not be evaluated at this time. Figures 2-1 and 2-2 display detected Aroclor-1248 concentrations for total and subsurface soils, respectively. Additionally, Figure 2-3 displays Aroclor-1248 concentrations with respect to sampling depth. The horizontal scale of this figure is simply arbitrary designation of a left to right view of the site.

Surface Soil (0-3 feet)

Aroclor-1248 was detected in all of the 116 soil samples obtained at this depth, with concentrations ranging from 0.17 to 23000 ppm. As can be seen in Figure 2-1, concentrations increased as samples approached the Pilot Plant. Of these 116 samples, 58 exceeded 10 ppm.

Subsurface Soil (>3 feet)

Aroclor-1248 was detected in 32 of the 42 soil samples obtained at this depth, with concentrations ranging from 0.10 to 1900 ppm. The maximum detected concentration occurred at a depth of 3 to 5 feet, less than 20 feet away from the Pilot Plant. Of the 32 detections, 16 exceeded 10 ppm.

Recharge Basin

Of the 66 locations, 5 were located in the area of the recharge basin. Aroclor-1248 was detected at all 5 locations, ranging from 0.1 to 176.5 ppm with the highest detected concentration found below 3 feet was 49.7 ppm. Of the 17 samples at this location, 7 exceeded 10 ppm.

NOTE: ALL UNITS PPM.

HOOKER RUCO SITE

FIGURE 2-1

SOIL SAMPLING ANALYTICAL
RESULTS FOR ARDCOR - 1248

EBASCO SERVICES INCORPORATED

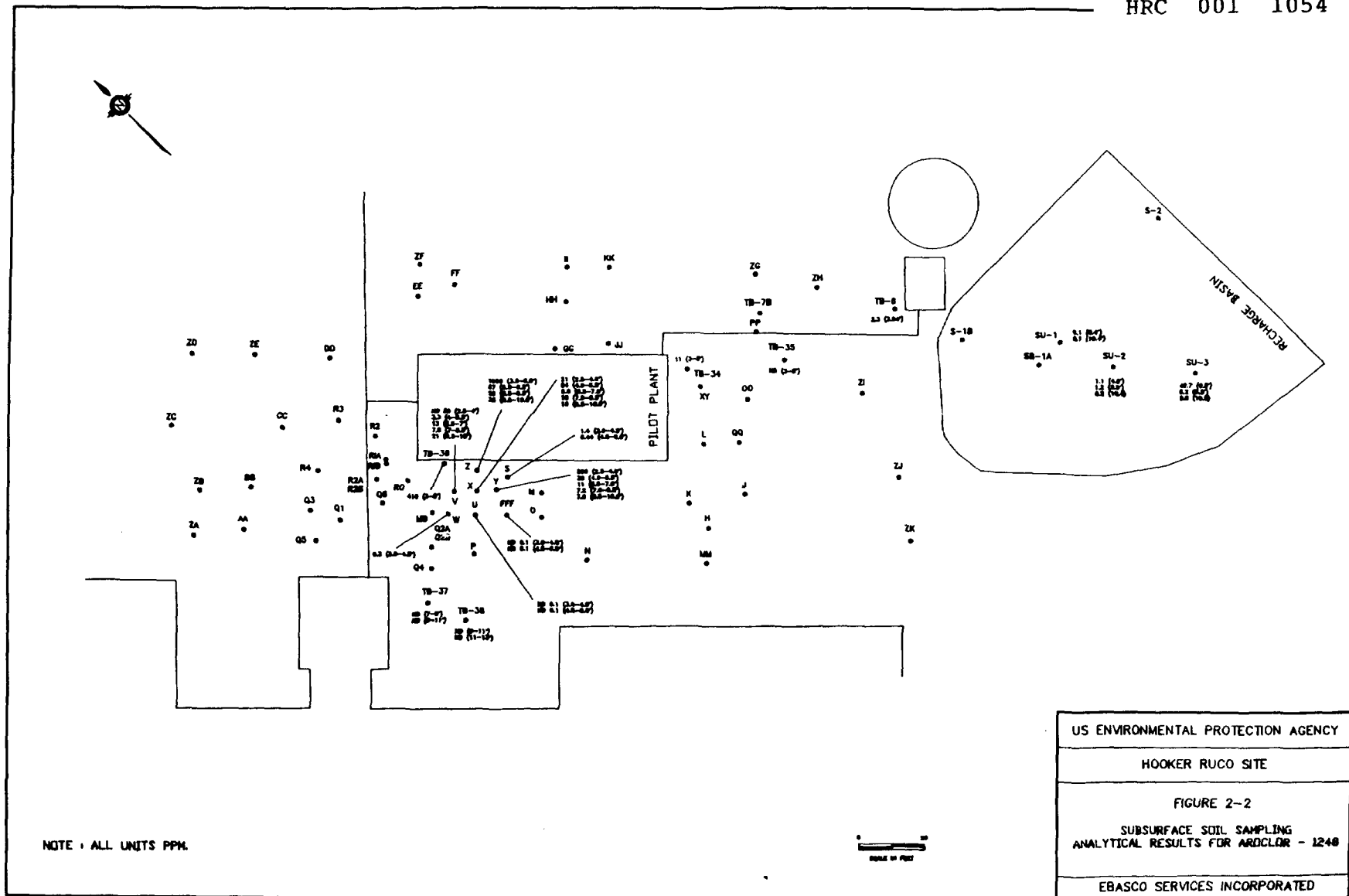
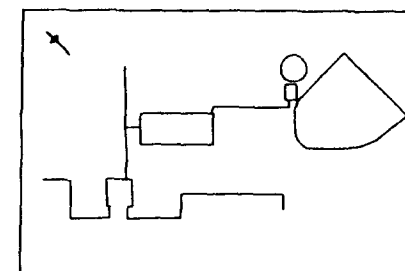
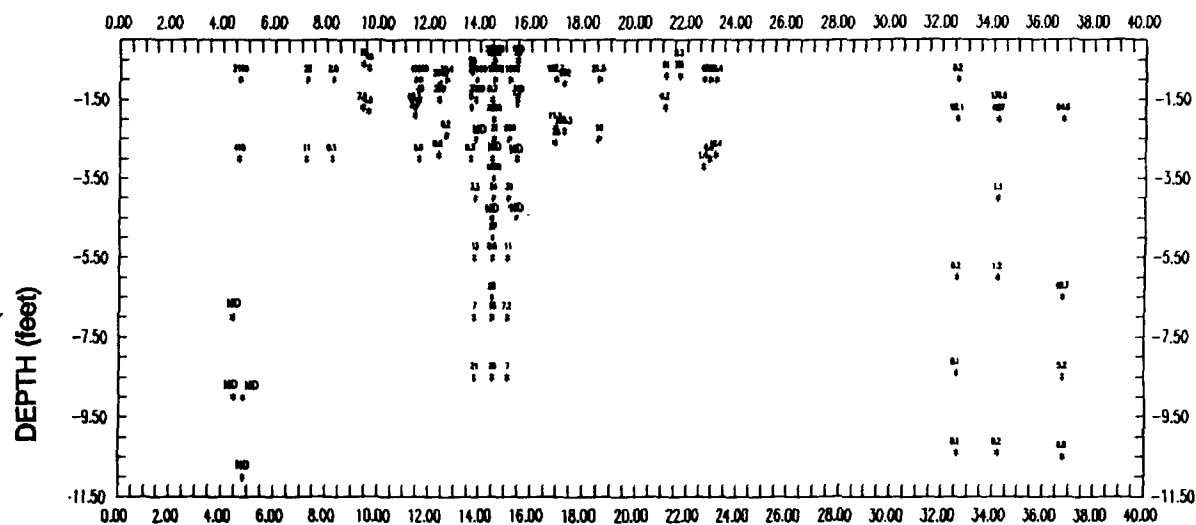


FIGURE 2 - 3

HOOKER/RUCO SITE

AROCLO-1248 CONCENTRATIONS WITH DEPTH (mg/kg)

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SITE PLAN KEY OF HORIZONTAL DISTANCE

X →

TABLE 2-1

HOOKER/RUCO SITE
AROCOR-1248 CONCENTRATION RANGE, FREQUENCY OF
DETECTION AND MEAN VALUE

Surface Soils (0-3 feet)

	<u>Range of Detected Values</u>	<u>Frequency of Detection</u>	<u>Upper 95% Confidence Interval</u>
Aroclor-1248	0.17-23000	116 of 116	2188

Subsurface Soils (<3 feet)

	<u>Range of Detected Values</u>	<u>Frequency of Detection</u>	<u>Upper 95% Confidence Interval</u>
Aroclor-1248	0.10-1900	32 of 42	692

Note: All units in ppm.

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Dirt Piles

Of the 92 locations, 21 samples were obtained during the field work of October, 1988, performed by LBG, from the area northeast and east of the Pilot Plant. Concentrations at these locations ranged from 0.7 to 420 ppm, with the maximum detection occurring at location #7. Of these samples, 20 locations had concentrations greater than 10 ppm.

QA/QC Considerations

Laboratory analysis of all soil samples was conducted via USEPA Contract Laboratory Program (CLP) protocols. Specifically, the USEPA "CLP Statement of Work (SOW) for Organic Analyses, Multi-Media, Multi-Concentration" (2/88) was used to analyze soil samples for Target Compound List volatiles, base/neutral and acid extractables, pesticides and PCBs; while the USEPA "CLP SOW for Inorganic Analyses, Multi-Media, Multi-Concentration" (12/87) was used to analyze soil samples for Target Analyte List inorganic constituents. Data validation of the subsequent laboratory analyses was performed using guidance entitled "CLP Organics Review and Preliminary Review" (4/89) and "SOP No. HW-2, Evaluation of Metals Data for the CLP" (12/87), in accordance with current USEPA Region II specifications at that time. The results of the data validation are found in Appendix 4 of the LBG RI report (April, 1990).

2.0.1.2 Soil Data Gaps

Although a significant number of samples have been obtained, evaluation of the PCB spill area soils data indicates that the extent of the contamination has not yet been delineated. Detectable concentrations of Aroclor-1248 extend to the northwest of the Pilot Plant (see Figure 2-1), where outlying sample location ZC had a detection of 10.9 ppm at a depth of 1 foot. Similar concentrations were detected in the vicinity of this location, where samples ZB and ZD had detected concentrations of Aroclor-1248 of 9.1 and 8.3 ppm (depth of 1 foot), respectively. No other samples were collected further from these points. Also not fully defined is the area to the south, where sample location ZV had a detection of 5.1 ppm at a depth of 1 foot. The LBG RI report (LBG, 1990) states additional samples have been collected in this area (TB-48, TB-49 and TB-P1), however corresponding analytical data is not provided.

The vertical extent of contamination has not been determined in a number of locations. Specifically, the areas indicated by samples V, X, Y and Z all extend down to a depth of 10 feet and exhibit significant concentrations. Sample location Z had a detection at 8 to 10 feet of 35 ppm with no other sample taken below this depth in this borehole. Other locations such as GG, HH, XY and TB-7 exhibit detections greater than 10 ppm at varying depths, without determining attenuation with depth. Samples collected in the Recharge Basin also do not reflect this fact.

A final data gap is the limiting of the analyses to evaluation of Aroclor-1248 alone. As stated later in Section 3.2. of this EA, the term "Aroclor" is simply a trade name for a class of compounds known as PCBs. The designation "1248" refers to a PCB mixture of 48% chlorine content. It is highly unlikely that the contaminant which has been spilled, Therminol (LBG, 1990), is limited to Aroclor-1248 content alone.

2.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Standard procedure for the selection of chemicals of concern is based on validity of the analytical results (i.e., results rejected during data validation were excluded), frequency of occurrence, concentrations relative to natural (background) levels and/or toxicological, physical, and chemical characteristics. If existing health-based data for an indicator chemical were lacking in the literature, then health-based data for a similar compound (i.e., same compound class) were used when possible for the chemical of concern. Data were summarized for each medium by presenting frequencies of detection, concentration ranges and 95% confidence interval of the geometric means of each contaminant. As specified in Section 1.3, only PCBs (Aroclor-1248) have been selected as a contaminant of concern. The following guidelines were used in evaluating the Hooker/Ruco site data:

- o To calculate the geometric mean for a medium in which a chemical was positively detected in one or more samples, non-detects were included in the mean by using one-half of each sample-specific detection limit. Where sample-specific detection limits were unavailable, one-half of USEPA's Contract-Required Quantitation Limit (CRQL) was used. This arbitrarily selected value (one-half) is commonly assigned to non-detects when averaging data for risk assessment purposes, since the actual value can be between zero and a value just below the detection limit (Vollmerhausen and Turnham, 1988).
- o In calculating upper 95% confidence intervals, samples in which the chemical was not detected at a detection limit two or more times higher than the maximum detected concentration in that medium, were not included. This was done to prevent the mean from being artificially biased upwards by high detection limits (USEPA, 1989a). These nondetects were, however, included in the determination of frequencies of detection. There is some uncertainty associated with this action since high detection limits may result in a chemical not being observed when it was actually present (i.e., false negatives).

- o Concentrations reported for duplicate samples at a given sampling point were averaged by calculating a geometric mean of the compounds and its associated duplicate. This mean value was used in the calculation of 95% CIs unless it was below the compound detection limit in which case the compound was treated as a non-detect.

The upper 95% confidence interval (CI) is calculated based upon the following equation (USEPA, 1989a):

$$95\% \text{ CI} = \frac{(\bar{X} + 0.5 S^2 + (SH/(n-1))^{1/2})}{e}$$

where

\bar{X} = arithmetic mean of log transformed data,
 S = the standard deviation of the transformed data,
 H = the student-T test at 5%, and;
 n = the number of valid analyses.

2.2 SUMMARY OF CHEMICALS OF POTENTIAL CONCERN

As previously stated in Section 1.3, PCBs (Aroclor-1248) have been designated by USEPA Region II as the solitary contaminant of concern.

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SECTION 3.0

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3.0 EXPOSURE ASSESSMENT

The purpose of this section is to identify the most significant potential pathways through which individuals may be exposed to PCBs in soil in the spill area surrounding the Pilot Plant. An exposure pathway is comprised of the following elements (USEPA, 1989a):

- o A source and mechanism of chemical release to the environment;
- o An environmental transport medium (e.g., soil) for the release chemical and/or mechanism of transfer of the chemical from one medium to another;
- o A point of potential contact by humans or animals with the contaminated medium; and
- o A route of exposure (i.e., inhalation, ingestion, dermal contact).

In identifying these potential exposure pathways, both current and likely future land-use of the site and surrounding area will be considered. Exposure pathways are presented for the No Action alternative, that is, assuming no site remediation occurs. This may be interpreted that no additional limits on site access or use would be instituted. The goal is to determine whether, under these conditions, it is possible that individuals could enter the site areas and engage in activities resulting in exposure to PCBs present in the PCB spill area soils.

This objective is achieved by first defining the physical setting of the site and potentially exposed populations. Secondly, the potential migration characteristics of the selected chemicals of concern are evaluated reflecting the above considerations. Finally, the potential exposure pathways most likely to be significant at the Hooker/Ruco site are determined.

3.1 CHARACTERIZATION OF EXPOSURE SETTING

3.1.1 Physical Setting

3.1.1.1 Climate and Meteorology

Nassau County, New York lies in a climatic section of eastern New York, termed the coastal region, which includes all of Long Island, New York City and the lowlands of Westchester and Putnam Counties. The coastal region is comparatively level, with elevations above sea level less than 50 feet over the greater part of Long Island, New York.

The climate of the coastal region is that of a maritime climate dominated by the adjacent Atlantic Ocean. Because of the ocean's proximity, the coastal region has relatively mild winters, not excessively warm summers, an abundance of precipitation well distributed through the year and a rather high relative humidity at 70 percent.

The average precipitation for the coastal region is 43.65 inches per year, based upon meteorological records between 1951 and 1980 at the Mineola, New York recording station. Table 3-1 presents precipitation data obtained during 1988 from two nearby observation stations at Mineola and Westbury, New York. As the table shows, precipitation is well distributed throughout the year, with a monthly mean of 3.67 inches. Meteorological information indicate that the frequency of precipitation events with 0.01 inch or more occur 130 days a year. Maximum precipitation for the coastal region over 1-hour and 24-hour periods is 1.10 and 2.75 inches, respectively (LBG, April 1990).

The water that replenishes the local groundwater system, groundwater recharge, is derived on Long Island solely from precipitation falling in watersheds. Some of the precipitation that occurs in these watersheds is lost each year to evaporation and transpiration, amounting to approximately 19 to 20 inches per year. Only a small percentage of the precipitation, less than 1 inch per year, is transported by surface runoff out of the coastal Long Island watersheds.

Although the precise amount is difficult to measure directly, USGS estimates of ground water recharge rates to glacial outwash sediments on Long Island are approximately 23 inches per year. Based upon these recharge rates, approximately 1.1 mgd (million gallons per day) per square mile is recharged to the groundwater system (LBG, April 1990).

The average daily temperature of the coastal region in the vicinity of the site is 53.2°F, based on historical temperature data at the Mineola observation station. Table 3-2 presents temperatures during 1988 at the Mineola and Westbury, New York recording stations. The coldest month of the coastal region is January, with an average temperature of 31.4°F while the warmest month is July, with an average temperature of 74.6°F.

Barometric pressures and wind directions are seasonal in the coastal region. The highest average barometric pressure occurs during the period between October and January, with 1,018 millibars of pressure. The lowest average barometric pressure is during the summer months of June, July and August, at 1,015 millibars of pressure. The general wind direction predominantly occurs from the west-northwest between 3 and 8 mph (miles per hour). During the summer months, however, prevailing winds are from the southwest at 3 mph. Throughout the year, wind speeds are below measurable limits only 2 percent of the time.

TABLE 3-1
HOOKER/RUCO SITE
SUMMARY OF PRECIPITATION DATA

MONTH	MINEOLA ⁽¹⁾ (inches)	WESTBURY ⁽¹⁾ (inches)	Average ⁽²⁾ (inches)
January	3.51	3.76	3.51
February	4.45	4.84	3.37
March	2.32	2.75	4.44
April	2.34	2.43	4.01
May	4.59	5.31	3.46
June	1.32	1.71	2.93
July	7.35	6.39	3.17
August	2.28	2.22	4.06
September	3.75	3.96	3.63
October	3.77	4.07	3.38
November	8.76	8.96	3.97
December	1.48	1.70	3.92
Totals	45.92	48.10	43.65

NOTE:

- (1) Based on Climatological Data - Annual Summary, New York, 1988, National Oceanic and Atmospheric Administration, Volume 100, Number 13.
- (2) The average value of the meteorological element over the time period 1951-1980 based on Mineola, New York precipitation average normals.

TABLE 3-2
HOOKER/RUCO SITE
SUMMARY OF TEMPERATURE DATA

MONTH	MINEOLA ⁽¹⁾ (°F)	WESTBURY ⁽¹⁾ (°F)	AVERAGE ⁽²⁾ (°F)
January	31.7	26.9	31.4
February	36.4	32.9	32.4
March	44.1	41.0	39.8
April	51.9	48.5	49.9
May	63.2	60.0	59.7
June	72.6	67.5	69.1
July	79.0	74.7	74.6
August	78.3	74.9	73.5
September	66.6	63.3	66.5
October	56.1(3)	48.5	66.4
November	49.5(3)	44.8	46.4
December	40.9(3)	33.7	35.1
Totals	55.8(3)	51.4	53.2

NOTE:

- (1) Based upon Climatological Data - Annual Summary, New York 1988; National Oceanic and Atmospheric Administration, Volume 100, Number 13.
- (2) The average value of the meteorological element over the time period 1951-1980 based on Mineola, New York temperature average normals.
- (3) Ten or more daily values were missed during the recording period and supplemental information is based on Climatological Data - Annual Summary, New York 1987.

3.1.1.2 Geology

Two hydrogeologic units that were identified during the LBG field investigation are the Glacial Formation and the Magothy Formation. The uppermost formation, the Glacial Formation, is composed of glacial outwash deposits ranging in thickness from 36 to 47 feet. There is little soil cover which overlies the very coarse-grained sediments. The formation consists of fine to very coarse sand, fine to medium gravel, cobbles and trace of silt. The sediments are brown to light tan in color. The basal sediments of the Glacial Formation range in thickness from 4 to 8 feet and are composed of very fine to medium sand, silt and, in some instances, clay. These sediments are iron stained and, in some instances, iron deposits are found. This is a transition zone between the Glacial and Magothy Formations. The basal sediments are either basal sediments of the Glacial Formation or disturbed sediments of the Upper Magothy Formation.

The Magothy Formation lies directly below the Glacial Formation and is typically composed of fine to coarse sand, clayey sand, silt and clay. The sands are generally light gray to tan in color, although some orange layers were found, while the clayey sediments are white, tan, gray and black. At Boring Locations H, Q and O, iron oxide was observed at approximately 40 to 65 feet in depth, and at Boring Locations G and I, it was observed at 70 to 100 feet in depth. The consistent occurrence of iron oxide at 65 feet may represent the historical low ground-water level.

The clayey sediments of the Magothy Formation are usually interbedded with very fine to fine sand lenses and, in some places, form non-continuous layers approximately 4 to 10 feet thick. Lignite was observed at Boring Locations L and S at a depth of 70 feet. The clayey sand layers were observed at the northern, southwestern and eastern boundaries of the plantsite. In other areas of the plantsite, two non-continuous clay layers, approximately 5 to 15 feet thick, were observed. The shallow clay layer was observed at 40 to 85 feet in depth at the northeastern and southwestern boundaries of the site, while a deep clay layer was observed at 95 to 130 feet in depth at the southwestern boundary of the site. During the field investigation, a third clay layer was encountered at 130 to 142 feet in depth at Boring Location S. Further details may be found in the LBG RI Report (April, 1990).

3.1.1.3 Surface Hydrology

The surface-water runoff in the study area is a direct result of precipitation. After a storm event, any precipitation which lands on impervious surfaces and cannot infiltrate is considered storm-water runoff. Storm-water runoff in the immediate vicinity of the site is collected by a storm-water catch basin and

directed through subsurface piping network to recharge basins, sometimes referred to as sumps. Once storm-water runoff reaches these basins, the water infiltrates through the bottom and sides of the basin until it reaches the water table. Some of the excess runoff water that cannot infiltrate is lost through evaporation and transportation. Watersheds or tributary areas for each recharge basin in the study area, have been delineated and represent areas where accumulated storm-water runoff is contained and allowed to infiltrate (LBG, April, 1990). There are thirteen recharge watersheds in the study area; some watersheds extend beyond the study area boundaries.

3.1.1.4 Groundwater

Long Island is underlain by consolidated bedrock, which in turn is overlain by a wedge-shaped mass of unconsolidated sediments. The top of the bedrock, which is approximately 20 feet below land surface in the northern edge of Nassau County, slopes to the southeast at an average slope of 65 ft/mile. The bedrock is poorly permeable to virtually impermeable crystalline metamorphic and igneous rocks. Although some fresh water exists in fractures within the bedrock matrix, the bedrock surface is considered the lower boundary of the regional ground-water aquifers on Long Island, New York.

The materials that overlie the bedrock surface are glacially-derived Pleistocene deposits and Upper Cretaceous fluvial and deltaic deposits. The Lloyd Aquifer, composed of fine to coarse sand and gravel in a clayey matrix, is contained under artesian pressure by the overlying Raritan Clay. Water supply from the Lloyd Aquifer, approximately 200 feet thick in the Hooker/Ruco area, is generally restricted in the north and south shores of Long Island because of the salt-water intrusion potential. Above the Raritan Clay, lies the Magothy Aquifer, which constitutes the principal water-supply unit throughout Long Island. It is approximately 550 feet thick at the Hooker/Ruco site. The Magothy Aquifer is chiefly composed of fine to medium sands, clayey in part, with some interbedded lenses of coarse sands and gravel. There are also many discontinuous clay layers within the aquifer. Predominantly, the Magothy Aquifer is moderately to very permeable. In the vicinity of the Hooker/Ruco site, all of the water-supply wells are completed in the Magothy Aquifer. The Magothy Aquifer is subject to salt-water intrusion in southwestern Nassau County, and has shown the effects throughout the county of septic system and industrial discharges.

The Magothy Aquifer is overlain by highly permeable Pleistocene glacial deposits. These deposits at the Hooker/Ruco site occur above the water table and form the majority of the unsaturated sediments ranging between 35 and 40 feet thick. In northern and

central Nassau County, the glacial deposits constitute a prolific aquifer, though its water quality has been impaired in many areas. The Glacial Aquifer is utilized primarily north of the Hooker/Ruco site, in the mid-island and north shore areas.

Shallow ground-water movement occurs from a relatively high area of the water table in the northeast corner of the Hooker/Ruco site, and flowing southeast, south and southwest in a fanshape direction away from the northeast corner. The predominant flow direction across the Hooker/Ruco site is toward the southwest. The relatively high water elevations (75.61 feet above mean sea level) in the northeast corner of the site correspond to a low permeability clay present directly below the water-table interface in this vicinity (Section 3.1.1.2 Geology). The low permeability sediments retard the downward percolation of recharging precipitation and strongly influence localized ground-water flow. Areas south of Plant 2, which includes the Pilot Plant, have been determined to have shallow horizontal groundwater velocities of approximately 0.25 ft/day.

3.1.1.5 Ecology

Pertinant information regarding ecology in the PCB spill area may be found in Section 5.3, Environmental Impacts Characterization.

3.1.2 Potentially Exposed Populations

3.1.2.1 Site Location With Respect to Study Area Population

The Hooker/Ruco site is located between South Oyster Bay Road and New South Road, transected by the Long Island Railroad, in the Town of Hicksville, Town of Oyster Bay, Nassau County, New York. The site itself is a triangular-shaped 14 acre property composed of parking, undeveloped land and industrial buildings. The area surrounding the site is comprised of an industrial corridor and residential complexes. Specifically, Commerce Street and adjacent industrial development border the site to the north. Along the site's 1,000-foot eastern boundary is a large warehouse building and a parking lot owned by Grumman Aerospace Corporation, with a small portion of undeveloped Grumman land adjacent to the site's 250-foot southern property boundary. Two active tracks of the Long Island Railroad parallel the site's 940-foot southwestern boundary and New South Road borders the property to the west.

In a 1 mile radius of the site are a mixture of large industrial and commercial areas, institutional areas and an airport. The largest industry in the area is the Grumman Corporation, which operates most of the industrial buildings to the east and south of the Hooker/Ruco site. The Grumman complex contains research and development facilities, assembly buildings, an airport, as well as the corporate headquarters. The nearest residential community is located 0.2 miles southwest of the site. Birmingham School, Lee Avenue School and a junior high school are all within this 1 mile radius, with Birmingham School being

the closest (approximately 3300 feet to the southwest). This school, as well as the Lee Avenue School, has been closed by the Town of Oyster Bay (personal communication, 1990). The nearest schools currently in operation are Hicksville High School and Bethpage High School, located 1 mile west and east, respectively, of the site. Also within this radius are six public supply wells, five of which belong to the Hicksville Water District and one to the Levittown Water District, which service approximately 100,000 people (NYSDOH, 1982). None of these wells are situated south of the site which would be affected by the proposed groundwater flow (LBG, April 1990).

In a 3 mile radius of the site is the Old Bethpage Landfill, located approximately 9000 feet east-southeast in the Town of Old Bethpage, Nassau County, New York. Data regarding off-site groundwater contamination from the Old Bethpage Landfill was obtained in a study by Geraghty and Miller in 1985 and 1986. Results indicated a landfill leachate plume to the southeast of the landfill consisting of numerous inorganics and chlorinated solvents. In September, 1988, a signed Consent Decree was issued by the United States District Court, Eastern District of New York, documenting a selected pump and treat remedial action for this landfill.

3.1.2.2 Demographic Characteristics of Study Area Population

Hicksville is an unincorporated town in the Town of Oyster Bay, Nassau County. Hicksville is bordered on the east by New Cassel and on the south by Levittown. It shares its northern border with Jericho and Plainview, and its western border with the town of Bethpage. The largest city in the vicinity is the City of Westbury, located approximately 6 miles to the west. The population of Hicksville as per 1989 estimates is 42,400 persons. Census data obtained for this area is presented in Table 3-3, while Table 3-4 provides national data as a comparison. Based on 1980 census data, projections are also made for Hicksville to the year 1994.

The 1980 median age for males (32.1) and females (35.4) in Hicksville is above the national average by approximately 3 to 4 years. Furthermore, census data for Hicksville suggest an aging population, with median average ages for males and females projected to be 35 and 39 respectively for 1989 and 37 and 40 respectively for 1994. Currently (1989 estimates), the majority of the population is within the 15 to 54 year range (approximately 55.6%), with a roughly equal distribution of males and females.

3.1.2.3 Health Status Information for Study Area Population

No sources were available which provide detailed and comprehensive data concerning health status at the municipal level in the study area. However, limited data was obtained for New York State, Nassau County and for the city of Westbury, regarding birth and mortality rates. Each subject is discussed individually below.

TABLE 3-3

HOOKER/RUCO SITE
AGE AND GENDER DISTRIBUTION FOR THE TOWN OF HICKSVILLE

Age Distribution	<u>1980 Census</u>		<u>1989 Estimates</u>		<u>1994 Projections</u>	
	Male	Female	Male	Female	Male	Female
0-14 years (% of total)	4074 19.3	3810 17.2	3224 15.7	3118 14.3	3096 15.6	2971 14.0
15-34 years (% of total)	7308 34.6	7140 32.2	7064 34.3	6714 30.8	6019 30.2	5809 27.5
35-54 years (% of total)	4875 23.1	5640 25.4	4753 23.0	5091 23.3	5411 27.3	5564 26.3
55-64 years (% of total)	3256 15.4	3337 15.1	2560 12.4	3161 14.5	1914 9.7	2360 11.1
65-74 years (% of total)	1170 5.6	1256 5.7	2289 11.1	2583 11.9	2383 12.0	3015 14.2
75 years and over (% of total)	442 2.1	937 4.2	697 3.4	1146 5.3	1032 5.2	1521 7.2
Total Persons	21,125	22,120	20,587	21,813	19,855	21,240
Median Age	32.1	35.4	35.0	38.7	37.2	40.4

NOTE:

- (1) Data obtained from Donnelly Demographics Census Information.
On-line computer database.

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TABLE 3-4

HOOKER/RUCO SITE
AGE AND GENDER DISTRIBUTION FOR THE UNITED STATES FROM
THE 1980 CENSUS

<u>AGE DISTRIBUTION</u>	<u>MALE</u>	<u>FEMALE</u>
0-14 years (% of total)	26,226,000 23.7%	25,077,000 21.5%
15-34 years (% of total)	40,008,000 36.2%	39,927,600 34.2%
35-54 years (% of total)	23,648,000 21.4%	24,904,000 21.3%
55-64 years (% of total)	10,180,000 9.2%	11,582,000 9.9%
65-74 years (% of total)	6,792,000 6.2%	8,862,000 7.6%
75 years and over (% of total)	3,576,000 3.2%	6,476,000 5.5%
Total Persons	110,430,000	116,828,000
Median Age	28.9	31.3

NOTE:

(1) Data obtained from United States Population Estimates by Age, Sex, and Race: 1980 to 1987, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 1022.

Premature Births, Neonatal Deaths and Infant Deaths

Table 3-5 summarizes available data regarding the incidence of premature births, neonatal deaths and infant deaths in the study area and in New York State for 1987. The city of Westbury was the largest municipality within a 5 mile radius for which data was obtainable. Westbury exhibited a higher incidence of premature births (defined as birth weight less than 2500 grams) than for Nassau County and the State as a whole. Similarly, neonatal and infant deaths was higher in Westbury when compared to county and state statistics.

Mortality Rates

As above, the city of Westbury exhibited higher mortality rates for heart disease, malignant neoplasms and cerebrovascular disease when compared to county and state statistics. Heart disease showed the highest rate of the three, with a rate of 455 per 100,000 population compiled for Westbury. Table 3-6 summarizes available data regarding mortality rates for 1987.

3.1.2.4 Current/Future Land Use of the Study Area

Present characteristics for industry in Hicksville are presented in Table 3-7.

As a result of the extensive industrial activity in the area, many current sources of environmental pollution exist in Hicksville, including the Grumman Aerospace Corporation. Historically, the Master Plan for Nassau County has been to site industrial communities within the center of Long Island without consideration for the mid-island's shallow groundwater recharge zone and its vulnerability to contamination. Presently, new industry is planned for the outer shores of Long Island to avoid future contamination of the groundwater (Ebasco, 1989).

3.2 FATE AND TRANSPORT IN RELEASE MEDIA

Environmental fate and transport of chemical elements and compounds are of major importance in the evaluation and quantification of the risks resulting from site contamination. The fate of a chemical in the environment and its movement through the environment are determined by chemical-specific attributes. Two major factors affecting the fate and transport of a chemical are chemical mobility and persistence. Mobility is a measure of the tendency for a chemical to move through the environment and is affected by chemical aqueous solubility, volatilization, sorption, hydrolysis, photolysis, and oxidation. Persistence, a measure of the time a chemical remains in the environment, is influenced by many of the factors affecting chemical mobility (including photolysis, hydrolysis, and oxidation) but is also a function of chemical-biological

TABLE 3-5

HOOKER/RUCO SITE
1987 INDICES OF FETAL AND INFANT HEALTH FOR
THE CITY OF WESTBURY, NASSAU COUNTY AND NEW YORK STATE(1)

	<u>WESTBURY</u>	<u>NASSAU COUNTY</u>	<u>NEW YORK STATE</u>
Premature Births(2)	97.2	61.1	76.0
Neonatal Deaths(2)	12.2	7.4	7.3
Infant Deaths(2)	17.4	10.2	10.6
Total Number of Births	576	16,504	271,355

NOTE:

- (1) All values, with the exception of total births, are rates per 1,000 population for 1987.
- (2) Premature is defined as a live birth with birthweight under 2500 grams; neonatal is less than 28 days of age; infant is less than 1 year of age.
- (3) Data obtained from Vital Statistics of New York State, Department of Health, Bureau of Production Systems Management, Annual Report for 1987.

TABLE 3-6

HOOKER/RUCO SITE
1987 MORTALITY RATES FOR THE CITY OF WESTBURY,
NASSAU COUNTY AND NEW YORK STATE⁽¹⁾

	<u>WESTBURY</u>	<u>NASSAU COUNTY</u>	<u>NEW YORK STATE</u>
Heart Disease	454.9	360.3	372.6
Malignant Neoplasms	296.0	229.8	214.1
Cerebrovascular Disease	72.2	44.6	53.2
Total Number of Deaths	166	11,730	171,418

NOTE:

- (1) All figures, with the exception of total deaths, are rates per 100,000 population for 1987.
- (2) Data obtained from Vital Statistics of New York State, Department of Health, Bureau of Production Systems, Annual Report for 1987.

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TABLE 3-7

HOOKER/RUCO SITE
INDUSTRIAL CHARACTERISTICS FOR THE
TOWN OF HICKSVILLE

<u>INDUSTRY</u>	<u>1980 CENSUS AMOUNT</u>	<u>PERCENTAGE OF TOTAL INDUSTRY</u>
Agriculture/Forestry/ Fishing	105	0.5%
Construction	876	4.0%
Manufacturing:		
- nondurable	1623	7.4%
- durable	2721	12.4%
Transportation	1221	5.6%
Communications	976	4.5%
Trade	5667	25.9%
Other (i.e., service, administration)	8678	39.7%

NOTE:

- (1) Data obtained from Donnelly Demographics Census Information,
On-line computer database.

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interactions in the environment. These interactions are identified by factors such as biodegradation and/or bioaccumulation.

Factors affecting environmental fate and transport of chemicals are briefly defined below.

- o Solubility is the measure of chemical dissolution in water and is expressed in units of chemical mass/volume of water (eg, ug/l or mg/l). Aqueous solubility is an important determinant of chemical concentration and residence time in water. Highly soluble chemicals readily dissolve in water and remain in solution whereas chemicals exhibiting low solubility tend to go out of solution, binding particulate matter and/or organics bound to particulate matter.
- o Volatilization describes the movement of a chemical from the surface of a liquid or solid matrix to a gas or vapor phase. This process is calculated from the equilibrium vapor pressure which measures chemical solubility in air (when the initial chemical concentration is in the liquid phase). Volatilization losses to air are correlated with chemical concentration, solubility and ambient temperature, and is a particularly important environmental fate process for chemicals exhibiting low aqueous solubility and polarity.
- o Sorption (adsorption/absorption) is the reversible binding of a chemical to a solid matrix. Both nonpolar and insoluble chemicals sorb strongly to sediments, suspended solids and soils. Sorption of these compounds limits the fraction available for other fate processes such as volatilization and/or hydrolysis. Partition coefficients, which are important measures of sorptive characteristics, define the relative concentration of a given chemical in two phases or matrices.
- o Partition coefficients are expressed as concentration ratios, and utilized in describing the environmental behavior of a compound. These parameters include K_{ow} , K_d and K_{oc} and are defined below:

K_{ow} : Ratio of chemical concentration in octanol (organic solvent) to that in water at steady state conditions

K_d : Ratio of chemical concentration in aqueous and solid phases at steady state conditions

K_{oc} : K_d normalized to concentration of organic carbon in solid phase

- o Bioaccumulation is the accumulation and transport of a chemical through the food chain. Potential for bioaccumulation is quantified by bioconcentration factors (BCFs) which define the ratio of pollutant concentration in animal or plant tissue to concentrations of the same chemical in the environmental media of contact (air, water or soil). Chemicals with high BCFs (such as PCBs) are typically insoluble and lipophilic (non-polar) and thus tend to reside in animal fat tissue. Literature values of BCFs most commonly pertain to fish species. Given that the Hooker/Ruco site contains no permanent standing water bodies, the bioaccumulative potential of Aroclor-1248, the sole contaminant of concern, is irrelevant. Bioaccumulation is discussed in these following sections only to complete the fate and transport profile.
- o Many microorganisms and biota are resistant to or develop resistance to chemicals (particularly organic chemicals) and can transform complex molecules to other compounds. Products of biotransformation/biodegradation may or may not be comparably toxic to other organisms). Biological transformation includes a variety of enzyme-catalyzed reactions such as oxidation and reduction.
- o Hydrolysis is the reaction of a chemical with hydrogen ions (H⁺), hydroxyl radicals (OH⁻) and water molecules. These components of water interact with or attack sites of a chemical resulting in its subsequent breakdown in the environment. The extent of chemical hydrolytic reactivity depends on both pH (acidity/alkalinity) and the molecular structure of the specific chemical.
- o Photolysis is a chemical decomposition process induced by radiant energy (sunlight). The rate of loss of a chemical from photochemical reactions depends on both its molecular structure and the proximity and character of the light source.
- o Oxidation is a chemical reaction which liberates negative electrons from a metal or other substance. Conversely, electrons are consumed in reduction reactions. Both oxidation and reduction reactions are environmentally significant in that they influence the rate of loss of a chemical from environmental matrices. Oxidized and reduced forms of the same chemical may exhibit totally different ecological and/or toxicological properties.

3.2.1 Identification of Contamination

"Polychlorinated biphenyls" refers to a class of organic compounds produced industrially by the chlorination of biphenyl with anhydrous chlorine. The resulting mixture of products arise from a specified number of chlorine substitutions on the

biphenyl molecule with the chlorine content of any product varying from 18 to 79 percent. Commercial PCB mixtures are manufactured under a variety of trade names. The term "Aroclor" is a registered trademark of Monsanto Industrial Chemicals Company, and Aroclor-1248 refers to a mixture of 48 percent chlorine composition. PCBs of this type have been used originally as a coolant/dielectric for transformers and capacitors, heat transfer fluids and protective coatings for wood (Hutzinger, Safe and Zitko, 1974).

3.2.2 Physical Properties of Contamination

Individual PCBs vary widely in their physical properties according to the degree and position of chlorination. Aroclor-1248 in particular is a clear, mobile oil with a distillation range of 340-375°C. Table 3-8 displays several additional chemical and physical properties of Aroclor-1248. As shown, this compound exhibits a water solubility of 0.017-0.054 mg/l and vapor pressure of 4.94×10^{-4} mmHg. The solubility of PCBs in water is generally low (Hutzinger, Safe and Zitko, 1974) and further decreases with increasing chlorine content. Reflecting the low solubility, the partition coefficient (K_d) for Aroclor-1248 exhibits an affinity for the solid phase.

3.2.3 Summary of Fate Data

Sufficient data exists for Aroclor-1248 as an individual compound, however, significant information may be found for PCBs as a class of compounds. Subsequent discussion regarding the fate and transport of Aroclor-1248 will reference PCB data in the absence of specific Aroclor-1248 information.

3.2.3.1 Solubility

Water solubilities in general range from less than 1 mg/l to completely miscible with water, with most common organic compounds falling between 1 mg/l and 10,000 mg/l (Lyman et al., 1982). PCBs exhibit low solubility in water primarily due to their aromaticity. The solubility of Aroclor-1248 (see Table 3-8) indicates that water-borne transport of PCBs is not likely to occur. Despite this characteristic, leaching of PCBs due to water-borne transport has occurred. Section 3.2.4 presents a screening level model of water-borne transport in the recharge basin area.

3.2.3.2 Sorption

Adsorption to soils/sediments or organic matter is a major process defining the environmental fate of PCBs. A high affinity for adsorption to organic matter is evident in the high log K_{oc} (5.38) and log K_{ow} (5.75 to 6.11) partition coefficient values for Aroclor-1248 (see Table 3-8). Water solubility and K_{oc} values among different PCBs are correlated with the number

of chlorine atoms on the molecule. Consequently, PCB congeners with lower numbers of chlorine atoms tend to sorb less strongly than the more heavily chlorinated molecules, such as Aroclor-1248, 1254 and 1260 (USEPA, 1987). Although adsorption can immobilize PCBs in soils and sediments, remobilization via leaching has been observed (Swackhamer and Armstrong, 1986). The strong adsorptive tendencies of PCBs suggest that most PCBs observed from the Hooker/Ruco site field investigation will be adsorbed in the soil samples.

3.2.3.3 Bioaccumulation

PCBs are bioconcentrated in numerous organisms at high levels, binding strongly to lipid (fatty) tissues. Typical bioconcentration factors for aquatic species (fish, shrimp and oysters) range from 26,000 to 660,000 l/kg (Leifer et al., 1983). USEPA (1986) has adopted a generalized non-species specific bioconcentration factor of 100,000. For reasons stated in the introduction of this section, the importance of this process is minimal at the Hooker/Ruco site.

3.2.3.4 Biodegradation/Biotransformation

Biodegradability of PCBs depends heavily upon both the degree of chlorination and the specific position of the chlorine on the biphenyl molecule (Brown et al., 1987 and Leifer et al., 1983). In general, mono-, di- and tri-chlorinated biphenyls degrade rather rapidly. Tetrachlorinated biphenyls degrade slowly while higher chlorinated biphenyls are resistant to biodegradation.

3.2.3.5 Volatilization

Volatilization of PCBs occurs, with fate limited to the vapor phase (Eisenreich et al., 1981). Atmospheric removal mechanisms include physically mediated wet and dry deposition, with dry deposition occurring only for PCBs attached to the particulate phase. Volatilization of PCBs from water has been shown to be a major removal mechanism of dissolved PCBs from natural waters (Swackhamer and Armstrong, 1986). Consequently, volatilization with concomitant atmospheric recycling via wet and/or dry deposition is a reasonably expected environmental fate process for PCBs.

3.2.3.6 Hydrolysis/Photolysis

PCBs are strongly bonded compounds which are not readily hydrolyzed (USEPA, 1979). PCBs may undergo photolysis in the atmosphere where they react with photochemically-produced hydroxyl radicals (USEPA, 1979). However, this is apparently a slow process, particularly for the highly chlorinated congeners (such as Aroclor-1248). Insufficient data are available to

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TABLE 3 - 8
Hooker/Ruco Site
Summary of Fate and Transport Data
For Aroclor-1248

Reference	Vapor Pressure (mmHg)	Solubility (mg/L)	Henry's Law Constant (atm-m ³ /mol)	Partition Coefficient (l/kg)	log K _{ow}	log K _{oc}	BCF
(1)	4.94E-04	0.054	--	--	6.11	--	--
(2)	4.94E-04	0.054	3.47E-03	1.17E+04	5.75	5.38	--
(3)	--	0.017	--	--	6.11	--	7.30E+04
(4)	4.90E-04	0.054	3.50E-03	--	--	--	--
(5)	4.94E-04	0.054	3.60E-03	--	5.76	--	--

Note :

-- : not measured in study.

(1) Callahan, M.A., et al. 1979

(2) Jaffe, P.R. and Ferrara, R.A. 1983

(3) Kenaga, E.E. and Goring, C.A. 1980

(4) Thomas, R.G. 1982

(5) Mabey, W.R., et al. 1982

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assess the importance of photolysis within aqueous systems. Hence, the extent to which photolytic factors into the ultimate environmental fate of PCBs has yet to be determined.

3.2.3.7 Oxidation

Oxidation is not considered to be a significant degradation process for PCBs (USEPA, 1979).

3.2.4 Model for Water-borne Transport of Aroclor-1248 to Recharge Basin and Groundwater Table

The presence of Aroclor-1248 in the recharge basin is indicative of two potential transport pathways; first that the PCB spill which occurred on the Hooker/Ruco site was in the recharge basin area, or secondly that the PCB spill occurred adjacent to the Pilot Plant. A generic screening model was employed to assess this problem by estimating Aroclor-1248 concentrations at a depth of 3-6 feet in the basin soils and assuming a spill near the Pilot Plant. In this model, a percentage of annual groundwater recharge volume into the basin was assumed to equilibrate with the 0-3 feet soils, solubilize PCB contamination, and percolate to the 3-6 feet depth where soils would readsorb contamination. If the calculated concentration in the 3-6 feet interval correlates with the average of contamination detected at this depth, water-borne transport of PCB contaminated soils in the area of the Pilot Plant may be supported.

Water-borne transport was estimated using a standard mass balance equation. Flow rate (Q) into the basin was determined by the following equation:

$$Q = SA \cdot IR$$

where

SA = surface area of the drainage basin (ft²), and;
IR = infiltration rate (ft/year).

Surface area of the drainage basin was estimated from Plate 2.2 of the LBG RI report (April, 1990) by following the 130 foot contour line around the basin and including the Pilot Plant. Infiltration rate was obtained by multiplying the average total rainfall for the city of Westbury by the percentage of precipitation attributable to groundwater recharge. Based on a report by the United States Department of the Interior (USDOI, 1972) for recharge basins in Long Island, N.Y, this value was reported to be approximately 50%.

Mass transport was subsequently evaluated by the following equation:

$$MT = \frac{(Q)(C_i)}{K_d} \times \frac{(28.32 \text{ liters})}{(1 \text{ ft}^3)}$$

where

Q = flow rate (ft^3/year),
 C_i = average soil concentration of the surface soil
(0-3 feet) in the recharge basin (mg/kg), and;
 K_d = partition coefficient ($1/\text{kg}$).

K_d was determined from K_{ow} values shown on Table 3-8. Using a $\log K_{ow}$ of 5.75 and the equation (USEPA June, 1987):

$$\log K_{OC} = 0.937 \log K_{ow} - 0.006$$

where

K_{ow} = octanol: water partition coefficient, and;
 K_{OC} = organic carbon partition coefficient.

Subsequently, a $\log K_{OC}$ of 5.38 was calculated. Multiplying the K_{OC} by the fraction of organic carbon (F_{OC}) present in the soils on the Hooker/Ruco site yielded a K_d value for Aroclor-1248 of 843 $1/\text{kg}$. The fraction of organic carbon used in this calculation was extracted from Contract Laboratory Program (CLP) laboratory analysis of total organic carbon on a Superfund site in Bethpage, Long Island, N.Y. (Ebasco, 1990) and was 0.35%.

Mass transport was calculated to be 285 g/year. Using this value and dividing by the contaminated volume of the drainage basin (5250 ft^3) and the bulk density of sandy soils, a mass flux of 1.2 mg/kg was determined. The bulk density was estimated to be $1.61 \text{ g}/\text{cm}^3$, assuming a soil particle density of $2.65 \text{ g}/\text{cm}^3$ and a total porosity of 0.39 (Ebasco, 1990). With the exception of the concentration of Aroclor-1248 at sample location SU-3 (6.5 foot interval), this value fall within an order of magnitude with the average concentration of the 3-6 feet depth soils ($0.65 \text{ mg}/\text{kg}$). Furthermore, the higher concentrations obtained at SU-3 are anticipated since this area is in the deepest portion of the basin, which most of the soil settling would occur. From this agreement, water-borne transport of PCB contaminated soil in the area of the Pilot Plant can be supported

A supplement to this model is the possibility for Aroclor-1248 to eventually leach downward due to percolation of rainwater to the groundwater table and subsequently migrate off-site. Although this process is difficult to evaluate, the rate of transport of this contaminant in groundwater may be discerned in part by partitioning between the mobile aqueous phase, the stationary soil particles and the organic matter which are in contact with the groundwater. The amount of time for the contaminant to transport off-site due to groundwater flow therefore is the sum of the migration time vertically to the groundwater table and the migration time horizontally off-site. The following approach will evaluate the rate of horizontal transport of Aroclor-1248 in the groundwater and determine the minimum amount of time for Aroclor-1248 to migrate off-site.

In order to estimate the migration of Aroclor-1248 in the groundwater, the following retardation equation was utilized:

$$V_C = V [1 + k_d(b/P_T)]^{-1}$$

where

V_C = the steady state velocity of the chemical at the point where $C/Co = 0.5$, where C is the concentration and Co is the initial concentration,
 V = average linear groundwater velocity,
 k_d = partition coefficient,
 b = bulk sand density, and;
 P_T = total porosity.

Total porosity and bulk sand density have been determined to be 0.39 and 1.61 g/cm³, respectively. Using a groundwater velocity under the Pilot Plant area of 0.25 ft/day (LBG RI, 1990) and a k_d of 843 l/kg calculated previously, a migration rate of 2.62×10^{-2} ft/year was obtained. Assuming the direction of groundwater flow to the southwest (LBG RI, 1990) and a distance from the Pilot Plant to the site border of 375 feet, approximately 14,000 years would be required for the contaminant to transport off-site.

3.2.5 Suspended Soil Emissions from the PCB Spill Area

A screening level model of fugitive particulate emissions from PCB spill area surface soils was applied in order to estimate potential human exposure to contaminated refinery soils present at the surface via inhalation. Equations developed by Cowherd et al. (USEPA 1985) were used to arrive at values for wind erosion releases and releases associated with vehicular traffic. Although this model was developed for emergency evaluations, EPA (1988) rates the degree of accuracy attained using this model as consistent with simplified quantitative estimation procedures.

The first step of each model is to determine the emission rate. For wind erosion particulate suspension calculations, a "limited reservoir" of erodible material model was used. The form of the equation (Cowherd et al., 1985) is as follows, with values used given at the end of each term.

$$E_{10w} = 0.83 \frac{f P(u^+) (1-V)}{(PE/50)^2}$$

where:

E_{10w} = PM₁₀ emission factor, i.e., annual average emission rate (of suspended matter less than 10 um in diameter) per unit area of contaminated surface (mg/m²-hr)

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- f = frequency of disturbance per month
(24 days per month)
- u^+ = observed (or probable) highest wind
velocity for the period between dis-
turbances (m/s) (22.5 m/s)
- $P(u^+)$ = erosion potential, i.e., quantity of
erodible particles present on the surface
prior to the onset of wind erosion (g/m^2)
- V = fraction of contaminated surface area
covered by continuous vegetative cover or
paved areas (equals 0 for bare soil) (10%)
- PE = Thornthwaite's Precipitation Evaporation
Index used as a measure of average soil
moisture content (139)

Although the previous equation is based primarily on field tests of nonsoil surfaces (e.g., coal with a top size of 3 cm and a silt content exceeding 4%), subsoil and other crustal materials showed similar behavior. The erosion potential (in g/m^2) depends on the peak wind velocity (in m/s) as follows:

$$P(u^+) = 6.7 (u^+ - u_t)$$

Where u_t is the erosion threshold wind speed (0.45 m/s at Hooker/Ruco site, measured at a typical weather station sensor height of 7m.

These equations were solved as follows:

$$P(u^+) = 6.7 (22.5 - 0.45)$$

$$P(u^+) = 147.7 \text{ g/m}^2$$

$$E_{10w} = 0.83 \frac{(24) (147.7) (0.9)}{(139/50)^2}$$

$$E_{10w} = 342.7 \text{ mg/m}^2\text{-hr}$$

For estimation of PM_{10} emissions from vehicle traffic over unpaved surfaces, the following emission equation was used:

$$E_{10v} = 0.85 \frac{S}{10} \frac{S}{24}^{0.8} \frac{W}{7}^{0.3} \frac{W}{6}^{1.2} \frac{365-p}{365}$$

where

- E_{10v} = PM_{10} emission factor, i.e., the quantity of PM_{10} emission from an unpaved road per vehicle-kilometer of travel (kg/VKT)
 s = percent silt content of road surface material (10%)
 S = mean vehicle speed (km/hr) (24)
 W = mean vehicle weight (metric ton) (5)
 w = mean number of wheels (16)
 p = number of days with at least 0.254 mm (0.01 in.) of precipitation per year (130)

For the Hooker/Ruco Site E_{10} was calculated to be:

$$E_{10v} = 0.85 \frac{10}{10} \frac{24}{24} \frac{0.8}{7} \frac{0.3}{6} \frac{1.2}{6} \frac{365-130}{365}$$

$$E_{10v} = 1.61 \text{ kg/VKT}$$

Emission rates (R_{10}) for contaminated soil from the site via wind erosion are determined from the above emission factors (E_{10}) using the following Equation:

$$R_{10w} = E_{10w} A$$

where

R_{10} = emission rate of contaminant as PM_{10}

E_{10w} = PM_{10} emission factor for wind erosion as given above

A = source extent or area (for a specified averaging time in the case of mechanical resuspension)

For wind erosion, the source extent is simply the contaminated area. At the pilot plant area the source extent was conservatively considered to be 3,729 m^2 assuming 10% building cover. The annual emission rate for contaminated soils was calculated as:

$$R_{10w} = (342.7 \text{ mg}/m^2\text{-hr}) (3,729 \text{ m}^2) = 355 \text{ mg/sec}$$

A wind erosion scaling factor Q_I is then applied to the wind erosion data for the specific climatic region. On the Hooker/Ruco site it is equal to:

$$\frac{355 \text{ mg/sec}}{0.296} = 1200 \text{ mg/sec}$$

In case of mechanical resuspension resulting from vehicular travel on unpaved surfaces, the source extent is found as the product of the contaminated travel length times the daily traffic count. At the Hooker/Ruco Site 10 vehicles per day were assumed to drive an on-site round trip distance of 0.1 kilometers.

$$R_{10v} = \frac{(1.61 \text{ kg})}{\text{VKT}} \frac{(10 \text{ vehicles})}{\text{day}} \frac{(0.1 \text{ Km})}{\text{vehicle}} = 1.61 \text{ kg/day} = 0.62 \text{ mg/sec}$$

In the case of mechanical resuspension, the scaling factor is equal to one.

The total emission rate (R_{10T}) is then the sum of the wind erosion and vehicular travel terms

$$\begin{aligned} R_{10T} &= R_{10w} + R_{10v} \\ &= 1200 \text{ mg/s} + 0.62 \text{ mg/s} \\ &= 1201 \text{ mg/s} \\ &= 1.2 \text{ g/s} \end{aligned}$$

This particulate generation term can then be combined with the air transport box model discussed below.

Estimates of Suspended Soil Concentrations of Aroclor-1248

A simple box model then was used to calculate ambient air concentrations of contaminants on and near the Hooker/Ruco site (USEPA, 1988). The box model is a standard approach used to estimate contaminant concentrations near and within an area source, where standard plume models are not very useful. The basic assumptions of the box model include a defined source area, with spatially uniform and temporally constant emission rates per unit area at all points within it, a constant wind direction and velocity, and receptors that are at a short distance from the source, relative to its crosswind width. The box model does not include considerations of local meteorologic conditions beyond the estimated average wind velocity, and neglects lateral diffusion or advection of contaminants in air. The estimate of ambient air contaminant concentrations generated by the box model is most accurate at the downwind boundary of the source where the downwind boundary is normal to the wind direction. The model estimates are less accurate for irregularly shaped sources, and where the downwind distance to the receptor is large relative to the crosswind width of the source. The basic box model can be formulated:

$$C_i = \frac{R_{10T}}{(H/2)WV}, \text{ where:}$$

- C_i = the ambient concentration of the i^{th} contaminant (g/m^3)
- R_{10T} = the release rate for the source (g/sec)
- H = height of the box (mixing height) (m)
- W = crosswind width of the source (m), and;
- V = wind velocity (m/sec)

The mixing height, H, can be estimated by solving the following equation (Pasquill, 1975):

$$x = 6.25 Z [H/Z \ln (H/Z) - 1.58 (H/Z) + 1.58]$$

where X is the downwind receptor distance, and Z is the roughness height corresponding to the site condition.

Air concentrations were calculated for a single distance exposure condition, corresponding to the exposure of site workers and trespassers. The roughness height, Z, was taken to be 0.1 m, a value typical of a suburban residential/commercial area (Cowherd, et al., 1985). For the downwind distance x, roughly one half of the width of the site (18.3 m) was assumed in order to conservatively estimate the concentrations at the center of the site. The mixing height therefore was estimated to be 1.97 m. Assuming a crosswind width of 104 m based on site contamination and an average wind velocity of 4.2 m/sec (CDM, 1985), an ambient concentration of 2.76 mg/m³ was calculated. This value was subsequently used for all inhalation pathways.

3.3 IDENTIFICATION OF EXPOSURE PATHWAYS

There are three general routes through which individuals could be exposed to Aroclor-1248 in the area of the PCB spill (area specified by Region II of USEPA): ingestion, direct contact and inhalation. The following sections discuss potential pathways relevant to each environmental medium associated with the site under present and future use scenarios. An identified pathway does not imply that exposures are actually occurring, only that the potential exists for the pathway to be complete. The exposure pathways most likely to be of concern to human health are listed below:

- o Ingestion/Direct Contact/Inhalation of Surface Soil
- o Ingestion/Direct Contact/Inhalation of Subsurface Soil

3.3.1 Soil Exposure Pathways

Present-Use Exposure Pathways

- o Site Workers

As previously mentioned, the Hooker/Ruco site is currently an active chemical manufacturing facility located in a heavily industrialized section of Hicksville. At present, the facility employs 96 personnel. On this basis alone, site workers must be considered as a potential receptor population under the present-use scenario. It is probable that site workers would ingest or come into direct contact with surface soil, or inhale suspended surface soil particulates during normal site activities. Therefore, these 3 exposure pathways for site workers were retained for evaluation.

o Trespassers

Also considered possible under the present-use scenario are trespassers who may frequent the site. This most likely encompasses children from the ages 12 to 17 (teenagers) who are using the site as a meeting ground. During their activities, such as bike riding, it is probable that these trespassers would ingest or come into direct contact with surface soil, or inhale suspended surface soil particulates. Although the occurrence of trespassers is considered unlikely since the site is generally inaccessible, this pathway has been evaluated using the same exposure pathways as for site workers.

A caveat to the inhalation pathway is that this evaluation will be performed on a qualitative basis only, since no information is available through USEPA risk assessment guidance regarding inhalation cancer slope factors, and current USEPA guidance (USEPA, 1989a) does not allow the use of oral cancer slope factors for inhalation scenarios. Therefore, although chronic daily intakes may be estimated, no health risk calculations will be made.

An exposure pathway not considered in this EA is the inhalation of site contaminants due to volatilization. Initial screening of this pathway using a model developed by Farino, et al. (1983) as described in the Superfund Exposure Assessment Manual (USEPA, 1988) indicated a mass flux of at least 5 orders of magnitude less than that of the suspended surface soil particulate flux. In light of this and the lack of inhalation risk factors, no further evaluation was performed.

Exposure by residents via ingestion, contact or inhalation was also not considered as a viable present-use scenario in this EA. Present conditions on-site do not allow access to residents, while the nearest residential complex is 0.2 miles to the southwest, across the Long Island Railroad. Additionally, the contaminants of concern are not likely to transport off-site (see Section 3.2.1).

Future-Use Exposure Pathways

The future-use scenarios include all of the soil exposure pathways discussed under present-use conditions but for different populations. Each scenario is discussed individually below.

o Construction Workers

Since the potential exists for future residential development of the Hooker/Ruco site, subsequent exposure to construction workers to excavated soils must be taken into consideration. During the construction of homes on the site, excavation and transport of site soils would be required. It is probable during these activities that construction workers would come into direct contact with or inadvertently ingest subsurface

TABLE 3-9

HOOKER/RUCO SITE
SUMMARY OF EXPOSURE PATHWAYS

<u>Potentially Exposed Population</u>	<u>Exposure Route, Medium and Exposure Point</u>	<u>Justification</u>
<u>Present-Use Scenarios</u>		
- Site Workers	Ingestion, direct contact and inhalation of site soils	Contaminated soil is in area utilized daily by site workers.
- Trespassers	Ingestion, direct contact and inhalation of site soils	Contaminated area may be frequented by teenagers.
<u>Future-Use Scenarios</u>		
- Construction Workers	Ingestion and direct contact of site soils	Area may be developed as a residential area.
- Residents	Ingestion and direct contact of site soils	Area may be developed as a residential area.

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soil. It is also likely that workers would also inhale suspended soil particulates, however this pathway was not retained for evaluation since it is being assessed under the present-use site workers scenario with a greater exposure.

o Residents

Upon the completion of construction of residential homes and the levelling of site soils, residents must be considered as a potential receptor population. It is probable during such activities as gardening that residents would come into direct contact with or inadvertently ingest subsurface soil. Therefore, this pathway was retained for evaluation.

The basement volatile inhalation pathway model on the site was not considered as an exposure scenario since volatilization of site contaminants at higher concentrations was determined to be not viable in the present-use pathway.

3.4 QUANTIFICATION OF EXPOSURE

3.4.1 Exposure Point Concentrations

In the development of exposure scenarios, both average and reasonable maximum exposure (RME) cases have been evaluated. The average case has been chosen to represent the exposure of a typical individual, whereas the RME scenario is intended to reflect a maximum, conservative exposure case. In accordance with USEPA guidance (USEPA, 1989a), exposure point concentrations for the average and RME case are based upon the upper 95 percent confidence limit on the arithmetic mean from site soil data. Specific values are presented for each scenario in the following sections.

3.4.1.1 Ingestion, Direct Contact and Inhalation of Site Soil

Exposure under these scenarios was considered for the present-use and future land-use pathway. For the present-use scenario in which trespassers and site workers will be exposed, the upper 95 percent confidence limit on the geometric mean for surface soils (0 to 3 feet depth) was used. Future-use of the site, which will expose construction workers as well as residents, also considered the 95 percent confidence limit on the geometric mean, but for subsurface soils (greater than 3 feet depth).

Exposure under the particulate inhalation scenario was considered for the present-use pathway. Section 3.2.5 presents a particulate suspension model and subsequent associated Aroclor-1248 concentration to be inhaled. However, as discussed in Section 3.3.1, current USEPA guidance does not permit the use of oral cancer slope factors in place of non-existent inhalation cancer slope factors. Therefore these pathways were evaluated on a qualitative basis only.

3.4.2 Exposure Parameters

3.4.2.1 Soil Exposure Frequency

Age-specific exposure parameter distributions were derived for each exposed population to account for variation over the lifetime of an individual. The number of days per year that an individual may be exposed to site contamination varied depended upon matrix, employment and exposure route. The range of days exposed per year was based on the average case and RME case scenarios, and was obtained where possible from the Exposure Factors Handbook (USEPA, 1989).

Site workers and trespassers were the only potential exposed populations to be considered in the present-use scenario. Average case potential exposure to site workers was assumed to occur five days per week for 37 weeks a year (185 days/year) for 9 years, assuming a two-week vacation period, five sick days and that 3 months of the year (December to February) the ground is frozen. Under the RME scenario, workers were assumed to be exposed five days per week for 39 weeks a year (195 days/year) for 30 years. For the trespasser scenario, it was assumed that teenagers are most likely to occasionally trespass on the site given its general inaccessibility within an industrialized area. The frequency of exposure estimated were derived by considering site-specific climate conditions. It is expected that during winter months, cold conditions and heavy clothing worn by individuals will limit the period during which exposure through ingestion and direct contact may occur. Therefore, time spent outdoors from December to February was not also included in the frequency of soil exposure estimates for trespassers. Subsequently under average exposure conditions, trespassers may come into contact with surface soil 2 days per week for 40 weeks a year (80 days/year) for approximately 5 years (teenager exposure). Under RME conditions it was assumed that trespassers may contact soil 4 occurrences a week for 40 weeks a year (160 days/year) for the same duration.

Similar to site workers, construction workers under the future-use scenario considered to be potentially exposed 185 days per year and 195 days per year for average and RME case exposures respectively. However, duration of exposure was assumed to be 1 and 3 years respectively, based upon the amount of construction time required. For the future-use scenario resident exposure, it was assumed that exposure would occur 12 and 24 hours per day for 9 and 30 years as the average and RME case exposure respectively.

3.4.2.2 Soil Exposure Variables

Soil Ingestion Pathway Variables

The soil ingestion rates for adults were assumed to be 100 mg/day for the average and worst case. A worst case ingestion

rate of 200 mg/day was assumed for teen-age trespassers. Soil ingestion are assumed to be incidental and to occur accidentally when soiled hands contact the mouth during activities such as eating, playing, or smoking. Children who regularly ingest large amounts of non-food materials, in a behavior known as pica, were not considered because occurrence of pica behavior and the associated rates of soil ingestion have not been well defined and "pathological" pica is rare (USEPA, 1989). The bioavailability factor used for average and RME case scenarios was 15%. This conservative absorption factor was selected after examining physiochemical properties and studies of TCDD (dioxin) absorption (Hawley, 1985). A summary of the parameters used is shown in Tables 3-10 and 3-11.

Dermal Pathway Exposure Variables

For dermal exposure, dermal soil deposition rates of 0.5 and 1.0 mg/cm² were used for representative and worst-case exposures, respectively (Schaum, 1985).

Dermal absorption factor values were selected for each class of compounds after reviewing published data and assumptions (e.g., Feldmann and Maibach, 1970; Hawley, 1985; Yang, et al., 1986a, 1986b). An average dermal absorption rate of 0.6% and a maximum dermal absorption rate of 1.2% were used for PCBs. These values were derived from studies by Schaum (1985) and Yang et al., (1986a, 1986b). Actual dermal absorption rates for contaminants from soil should be below values determined in experiments, because compounds are often dissolved in solvents, such as acetone and hexane, which allow greater permeation of compounds into the skin than soil or water media. A summary of the parameters used is shown in Tables 3-10 and 3-11.

Soil Inhalation Pathway Variables

Respiratory volumes were taken from the Exposure Factors Handbook (USEPA, 1989). Representative exposure scenarios assumed that individuals were engaged primarily in light activities, such as walking on level ground and sitting, while the reasonable maximum exposure scenario assumed individuals engaging in periods of heavy activities such as vigorous lifting of materials. Daily inhalation exposures were obtained by multiplying the hourly inhalation rate by the number of hours exposed. Site workers were assumed to be exposed 8 hr/day for 185 and 195 days per year, for the average and RME scenarios respectively. Trespassers were assumed to be exposed 4 hr/day for 80 and 160 days per year, for the average and RME scenarios respectively.

Based on data by ICRP (1980), an average inhalation bioavailability factor of 25%, and an RME inhalation bioavailability factor of 100% was used. Inhalation parameters are summarized in Table 3-10.

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TABLE 3 - 10
Hooker/Ruco Site
Parameters and Assumptions Used to Calculate
Potential Risk From Contaminants in
Soil Ingestion and Direct Contact Exposure Pathways
PRESENT-USE SCENARIOS

CASE ESTIMATE :	SITE WORKERS		TRESPASSERS	
	<u>Average</u>	<u>Reasonable Maximum</u>	<u>Average</u>	<u>Reasonable Maximum</u>
Frequency of Exposure - Year (365 days)	185	195	80	160
Duration of Exposure - Lifetime (75 years)	10	20	5	5
<hr/>				
Soil Ingestion (mg/day)	100	100	100	200
Ingestion Bioavailability Factor	0.5	1.0	0.5	1.0
<hr/>				
Skin Soil Deposition (mg/cm ²)	0.5	1.0	0.5	1.0
Skin Surface Area Exposed (cm ²)	3510	8320	3510	8320
Dermal Contact Bioavailability Factor	0.60%	1.20%	0.60%	1.20%
<hr/>				
Body Weight (kg)	70	70	56	56

Source :

Exposure Factors Handbook (USEPA, 1989)

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TABLE 3 - 10 (cont)
Hooker/Ruco Site
Parameters and Assumptions Used to Calculate
Potential Risk From Contaminants in the
Inhalation Exposure Pathway
PRESENT-USE SCENARIOS

CASE ESTIMATE :	SITE WORKERS		TRESPASSERS	
	<u>Average</u>	<u>Reasonable Maximum</u>	<u>Average</u>	<u>Reasonable Maximum</u>
Hours of Exposure	8	8	4	4
Frequency of Exposure - Year (365 days)	185	195	80	160
Duration of Exposure - Lifetime (75 years)	10	20	5	5
Respiratory Volume (m ³ /hr)	1.4	3.0	1.4	3.0
Bioavailability Factor	0.15	0.15	0.15	0.15
Suspended Soil Concentration (ug/m ³)	2.76	2.76	2.76	2.76
Body Weight (kg)	70	70	56	56

Source :

Exposure Factors Handbook (USEPA, 1989)

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TABLE 3 - 11
Hooker/Ruco Site
Parameters and Assumptions Used to Calculate
Potential Risk From Contaminants in
Soil Ingestion and Direct Contact Exposure Pathways
FUTURE-USE SCENARIOS

CASE ESTIMATE :	RESIDENTS		CONSTRUCTION WORKERS	
	<u>Average</u>	<u>Reasonable Maximum</u>	<u>Average</u>	<u>Reasonable Maximum</u>
Frequency of Exposure - Year (365 days)	43	130	185	195
Duration of Exposure - Lifetime (75 years)	9	30	1	3
<hr/>				
Soil Ingestion (mg/day)	100	100	100	100
Ingestion Bioavailability Factor	0.5	1.0	0.5	1.0
<hr/>				
Skin Soil Deposition (mg/cm ²)	0.5	1.0	0.5	1.0
Skin Surface Area Exposed (cm ²)	3510	8320	3510	8320
Dermal Contact Bioavailability Factor	0.60%	1.20%	0.60%	1.20%
<hr/>				
Body Weight (kg)	70	70	70	70

Source :

Exposure Factors Handbook (USEPA, 1989)

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Body Surface Area and Body Weights

A probability distribution of skin surface area exposed to soil was derived from age-group-specific data as given in the Exposure Factors Handbook (USEPA, 1989) and Hawley (1985). For adults, the average exposure value was based on the 50th percentile (except adults), and the worst-case exposure value was based on the 95th percentile. For children ages 0-17 skin surface areas were calculated by averaging those of a 2 1/2 year old, a six year old and an adult. In all cases, the average exposure scenario assumes exposure to the hands and arms only, and the worst-case scenario assumes exposure to hands, arms, feet and lower legs.

Probability distributions for body weights were derived from the data contained in the Exposure Factor Handbook, (USEPA, 1989). The body weights used for all scenarios correspond to the 50th percentile for each age group.

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SECTION 4.0

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4.0 TOXICITY ASSESSMENT

Discussed in this section are brief summaries of the potential health effects of Aroclor-1248. Additionally, dose-response values that will be used to evaluate human health risks are determined.

4.1 CLASSIFICATION OF TOXICITY EFFECTS

Aroclor-1248, chosen as the solitary contaminant of concern, is considered by USEPA as a potential carcinogenic compound only. For the purpose of this endangerment assessment, no evaluation of non-carcinogenic effects will be made.

4.1.1 Health Effects Criteria for Carcinogenic Effects

For chemicals that exhibit carcinogenic effects, USEPA as well as other scientific authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This is the non-threshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of carcinogenic action for the chemical.

USEPA's Carcinogen Assessment Group (CAG) has developed slope factors (i.e., cancer potency factors or dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The slope factor [in units of (mg/kg body weight/day)⁻¹] is a number which, when multiplied by the lifetime average daily dose of a potential carcinogen (in mg/kg body weight/day), yields the upper bound lifetime excess cancer risk associated with exposure at that dose. Upper bound is a term used by USEPA to reflect the conservative nature of the slope factor; risks estimated using slope factors are considered unlikely to underestimate actual risks but they may overestimate actual risks for a given exposure. This multiplication approach can be used for low doses corresponding to cancer risks lower than 10^{-2} (one in one hundred). Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of 1×10^{-6} (one in one million), for example, represents the incremental probability that an individual will develop cancer as a result of exposure to a carcinogenic chemical over a 75-year lifetime under specified exposure conditions. USEPA has suggested developing remedial alternatives for cleanup of Superfund sites to achieve total excess lifetime cancer risks ranging from no more than 10^{-4} (one in ten thousand) to 10^{-6} (one in a million) (USEPA 1989).

In practice, slope factors are derived from the results of human epidemiology studies or chronic animal bioassays. For the latter, data from animal studies are fitted to the linearized multistage model and a dose-response curve is obtained. The 95th percentile upper confidence limit slope of the dose-response curve is subjected to various adjustments, and an interspecies scaling factor is applied to conservatively derive the slope factor for humans. Thus, the actual risks associated with exposure to a potential carcinogen quantitatively evaluated based on animal data are not likely to exceed the risks estimated using these slope factors, but they may be much lower. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad-hoc basis. These models provide approximate, but plausible, estimates of the upper limits on lifetime risks.

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. USEPA (1986b) has proposed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data. The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies and (2) the quality of evidence from animal studies which are combined into a characterization of the overall weight of evidence for human carcinogenicity, and then (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. USEPA's final classification of the overall weight of evidence has the following five categories:

Group A--Human Carcinogen. This category indicates that there is sufficient evidence from human epidemiological studies to support a causal association between an agent and cancer.

Group B--Probable Human Carcinogen. This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C--Possible Human Carcinogen. This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D--Not Classified. This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E--No Evidence of Carcinogenicity to Humans. This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies.

Slope factors are developed based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. In accordance with recent USEPA (1989a) guidance, slope factors were only used for the route exposure they were based on (e.g., oral slope factors were not used to evaluate the inhalation route of exposure). The only exception to this rule was that oral slope factors were used to evaluate dermal exposure, as directed in USEPA's recent Superfund risk assessment guidance (USEPA 1989a).

4.2 RANGE OF POTENTIAL HEALTH EFFECTS FOR SELECTED CHEMICALS OF POTENTIAL CONCERN

This section of the EA presents a brief summary of the critical human health effects associated with long-term (chronic) exposure to each of the selected chemicals of concern. Although exposures to chemicals at Superfund sites are not generally associated with adverse effects from high level short term exposures (acute effects), this section includes information on acute effects for completeness. In addition, the available health effects criteria for use in risk assessment (slope factors and RfDs) for the chemical of concern is presented. The data that provide the basis for the health criteria values are also discussed. Information on potential human health effects is primarily obtained from information in USEPA guidance and from published toxicological and epidemiological studies.

Polychlorinated Biphenyls (PCBs)

o Absorption

The efficiencies with which PCBs are absorbed following exposure via the inhalation and ingestion routes have been reported to equal >50 and >90 percent, respectively (USEPA, April 1988). Absorption efficiency via the dermal route has been variously reported to equal 5 to 10 percent (USEPA, 1986) or, more recently, up to 59 percent (USEPA, April 1988). According to the U.S EPA's 1988 Drinking Water Criteria Document:

"Several dermal studies with PCB congeners or mixtures demonstrate that these compounds are readily absorbed and elicit toxic or biologic effects at dermal and distal sites..... A recent study by Westar, et al. (1983) reported the dermal absorption in guinea pigs and monkeys of synthetic ¹⁴C-labeled PCBs containing 42 and 54% chlorine (by weight)....".

"The estimated absorption of the 42 and 54% ¹⁴C mixtures was 33 and 56%, respectively, in the guinea pigs and the absorption of the 42% mixture varied between 15 and 34% depending on the dose (4.1 ug/cm² or 19.3 ug/cm²; source document, pp. III-6 to III-7)".

As a first approximation, it is appropriate to assume that absorption efficiency via inhalation and ingestion are equal to 100 percent, given the indefinite upper bounds signified by ">50 and >90 percent." However, absorption by these routes is actually likely to be significantly less than 100 percent. This is particularly so in the case of PCBs which may be tightly bound to particles, such as soil, and may therefore be to a large degree biologically unavailable.

o Distribution

The principal tissues and organs to which PCBs are distributed following absorption have been reported to include liver, muscle, fat, and skin (USEPA, April 1988).

o Metabolism

PCB metabolism occurs principally in the liver, involving the mixed function oxidase system of enzymes and, specifically, aryl hydrocarbon hydroxylases (AHH). Metabolism proceeds by epoxidation (formation of reactive epoxides, tricyclic -C-O-C- groups), ring hydroxylation (addition of OH⁻ groups to ring carbons), and oxidation of the remaining catechol (o-diphenol) nucleus (Klaassen, et al., 1986). Metabolic rates of PCBs vary inversely with pattern and degree of chlorination; more highly chlorinated congeners are typically metabolized more slowly than less chlorinated congeners. Mono-, di-, and tri-chlorinated biphenyls may be metabolized to a variety of hydroxy-, dihydroxy-, and methoxy-chlorinated biphenyl compounds, as well as to excretable glucuronide conjugates.

The rates of tetra-chlorinated biphenyl metabolism depend markedly upon their pattern of chlorination, but produce structurally similar though not identical metabolites. Penta- and hexa-chlorinated biphenyls are metabolized to di-, tri-, and tetra-chlorinated congeners, and undergo further metabolism as described above, as possibly do the higher-chlorinated congeners as well. Major metabolites are phenols and, possibly, potentially carcinogenic electrophilic arene oxide intermediates (USEPA, April 1985).

o Excretion

PCBs are highly persistent in the human body, but excretion does occur (USEPA, April 1985). Half-times for PCB excretion in animal studies were reported as being up to 100.5 days. Some unaltered PCB was found in the feces, but PCB metabolites appear

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to be exclusively excreted in conjugated form, principally if not exclusively in the urine. Conjugates included glucuronides of hydroxylated metabolites, as well as glutathione and other sulfur-containing substances detected in the urine of mice and rats. In humans, evidence of excretion has been derived from an outbreak of poisoning by PCB-contaminated rice oil in Taiwan. Calculated half-lives for the 2,4,5,2',4'-penta- and the 2,3,4,3',4'-penta-chlorinated biphenyl isomers were 9.8 and 6.7 months, respectively, in blood, although it cannot be assumed that disappearance from blood indicates elimination from the body (see Distribution subsection).

Pharmacodynamics

o Acute Toxicity

Acute toxic effects associated with PCBs can occur in humans under unusual, and unusually intense, exposure scenarios, such as in intentional or accidental poisoning. Numerous investigations of the toxic properties of acute exposure to PCBs have been undertaken, involving such bioassay organisms as mice, rats, hamster, rabbits, and monkeys (USEPA, April 1985). LD₅₀ values have been reported as being from 0.65 g/kg in mice following intraperitoneal injection to 19.2 g/kg in rats following oral administration. Toxicity appears to decline with increasing chlorination. Effects in animals have included weight loss, elevation of liver weight (hepatomegaly) and fat content, depressed body temperature and appetite, thymus gland hemorrhage, kidney enlargement, splenic and lymph node regression, increased thyroid gland activity, alterations in cholesterol and fatty acid synthesis, and other effects. Although LF₅₀ values for humans appear to be unknown, PCBs have been rated moderately toxic, having a probable oral LD₅₀ value in the range of 0.5-5 g/kg (Gosselin et al., 1984).

o Mutagenicity

PCBs bioassayed for mutagenic potential in microbial systems have apparently not exhibited genotoxicity except following metabolic activation (USEPA, April 1985). In test systems using metabolic activation, such as by rat liver homogenates, genotoxic potency increased with decreasing chlorination. PCBs tested by various routes were negative in the dominant lethal assay in rats, as well as tests for clastogenic activity in fruit flies, cytogenetic damage production in rat spermatogonia, chromosome aberrations in bone marrow of rats, and micronucleated polychromatic erythrocytes (PCEs) in mice. One study reporting positive results involved PCB causation of chromosomal aberrations in 3-6-day-old ring dove embryos following feeding of mothers with Aroclor 1254 at 10 ppm for an extended period of time (USEPA, April 1985).

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o Carcinogenicity

A significant body of literature pertains to the carcinogenicity of PCBs to animals, whereas only inconclusive epidemiological evidence pertains to causation of cancer in humans. Much of the animal data documents causation of liver cancer in rodents, and the significance of such data in the context of human risk is controversial for reasons relating to the observation that laboratory strains of rodents exhibit a relatively high spontaneous liver tumor incidence. However, recent research seems to have moved the weight of evidence toward significance since Reynolds et al. (Reynolds et al., 1987) reported that chemically induced liver tumors in rodents differed significantly with respect to their spectrum of activating mutations compared with tumors observed in untreated animals. There is little controversy about the significance to humans of genotoxic animal carcinogens. However, the rodent data discussed below must still be interpreted in the context of uncertainty because not all chemically induced rodent liver tumors necessarily differ from spontaneous (non-chemically-induced) tumors.

Several studies have revealed the ability of PCBs to induce liver tumors in rodents. Ito et al. (1978) reported that 5 of 12 mice fed a diet including 500 ppm of PCB (Kanechlor 500) exhibited the hepatocellular carcinoma, whereas none of the six control mice exhibited the cancer. Likewise, Kimbrough et al. (1975) observed a significant increase in the incidence of hepatocellular carcinoma in female rats fed 100 ppm of Aroclor 1260 for 21 months. Male rats were not studied. Twenty-six of 184 female rats fed PCB exhibited tumors, compared with only one of 173 control female rats. Moreover, 146 of the 184 treated rats exhibited neoplasms of their livers, compared with none of the controls. Kimbrough and Linder (1974) investigated PCB causation of hepatomas in mice. Nine of 22 mice fed 330 ppm of Aroclor 1254 for 11 months exhibited hepatomas, compared with no hepatomas exhibited among 100 control mice. Nagasaki (1972) reported that among 12 male mice fed Kanechlor 500 at 500 ppm, seven exhibited multiple liver tumors, whereas controls exhibited no remarkable changes in their livers.

The National Cancer Institute (NCI) conducted a long-term bioassay to evaluate the carcinogenicity of PCBs administered to rats via the diet (NCI, 1978). Aroclor 1254 was not proven carcinogenic, though adenocarcinomas of the gastrointestinal tract appeared in treated but not control animals. NCI indicated that the low historical background incidence of such lesions in its laboratory suggested that their elevated occurrence in the PCB bioassay was caused by PCB. Moreover, PCB appeared to be a promoter rather than a complete carcinogen, based upon evidence consisting of a high, statistically significant incidence of hepatocellular proliferative lesions observed in both males and females. This result confirms the results of other investigators indicating that PCB is a promoter

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of hepatocarcinomas (Ito et al., 1978; Kitigawa et al., 1977; Nishizumi, 1976; Peraino et al., 1971; Peraino et al., 1974; and Weisburger et al., 1975). Likewise, Aroclor 1254 was a promoter of tumors in mice treated with TCDD. Kimura et al. (1976) found PCB to be a promoter of hepatocarcinomas in rats, with tumor incidence reaching 64 percent among rats which were first administered the known carcinogen 3-methyl-4-dimethylamino-azobenzene (3'-Me-DAB). The investigators concluded that their results strongly suggest that PCBs exert a potent promoting action in experimental azo dye hepatocarcinogenesis.

o Teratogenicity

PCBs or their metabolites have been shown to cross the mammalian placenta, in mice and rats (USEPA, September 1984), as well as humans. Little evidence of teratogenicity exists, however (USEPA, April 1985). Data relating to PCB teratogenicity following inhalation are apparently completely unavailable. Teratogenicity was, however, demonstrated in a gavage study of pregnant CD-1 mice exposed during days 6-15 of gestation (USEPA, September 1984). At doses (of the PCB 3,3',4,4',5,5'-hexachlorobiphenyl) of ≥ 2 mg/kg/d, significantly elevated and dose-related incidence of cleft palate appeared and at ≥ 4 mg/kg/d hydronephrosis (kidney dilation due to obstruction of urine flow) appeared. A recent study (Pantaleoni et al., 1988) has revealed causation of behavioral teratogenic effects in Fischer 344 rats maternally exposed to PCB (Fenclor 42) at levels too low to affect birth size and maturation or to cause gross physical malformations.

Specifically, the investigators administered 1 - 2 mg/kg/d of PCB by gavage for 20 days to lactating females, and compared several behavioral capabilities of treated vs. control pups. Statistically significant behavioral deficits, such as reduced head raising during swimming, were observed in both dose groups.

o Reproductive Effects

Although PCBs are known to have an affinity for the uterus and fetotoxic effects have been documented, little information appears to be available relating to the effects of PCBs upon the reproductive systems of adult humans or animals (Rogan et al., 1988). Recent epidemiological studies (Klaassen et al., 1986; USEPA, September 1984; USEPA, April 1985; Taylor et al., 1989; and Rogan et al., 1988) follow up a 1979 incident in Taiwan of mass poisoning of individuals using cooking oil contaminated with thermally degraded PCBs. In 1985, 225 children were examined, including 117 born to affected women. The children born to exposed women were assumed to be exposed in utero to persistent PCB residues in maternal tissues, and were reported to differ from control children. The authors concluded that "exposed children were shorter and lighter than controls; [and] they had abnormalities of gingiva, skin, nails, teeth, and lungs more frequently than did controls".

In another recent epidemiological study (Taylor et al., 1989), a statistically significant dose-response relationship was observed between increased estimated serum PCB level and decreased birth weight and gestational age among women who had been occupationally exposed to PCBs (Aroclors 1254, 1242, and 1016).

Several studies have been conducted involving animals on reproductive failures. Complete reproductive failure has been induced in minks by PCB dietary levels of 5 mg/kg, specifically Aroclor 1242 (USEPA, April 1985). Lengthened estrus cycles were induced by PCBs in mice exposed to 0.025 mg/d of Clophen A-60. Irregular menstrual cycles and reduced serum progesterone levels were exhibited by monkeys fed Aroclor 1248 at 2.5 mg/kg. Male rats exposed to Aroclor 1254 from birth exhibited reduced impregnation of females after 130 days of treatment, indicating impaired mating behavior.

o Dose-Response Parameters

USEPA (1989) classified PCBs as a Group B2 agent (Probable Human Carcinogen) based on sufficient evidence in animal bioassays and inadequate evidence from studies in humans. IRIS (Integrated Risk Information System) reports an oral slope factor of $7.7 \text{ (mg/kg/day)}^{-1}$ for PCBs. At the time of this report, no information was available for inhalation of PCBs nor of non-carcinogenic effects. Table 4-1 presents all available dose-response information for PCBs.

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TABLE 4 - 1
Hooker/Ruco Site
Toxicity Data For Non-carcinogenic
and Potentially Carcinogenic Compounds
DOSE-RESPONSE EVALUATION *

Chemical Name	NONCARCINOGENS : Reference Doses		CARCINOGENS : Slope Factors			
	Oral RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)	Oral SF (mg/kg-day) ⁻¹	Weight of Evidence	Inhalation SF (mg/kg-day) ⁻¹	Weight of Evidence
PCBs (AROCLO-1248)	--	--	7.70 *	B2	ND	B2

EPA Weight of Evidence Classifications are as follows:

Group A - Human Carcinogen. Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.

Group B1 - Probable Human Carcinogen. Limited evidence of carcinogenicity in humans from epidemiological studies.

Group B2 - Probable Human Carcinogen. Sufficient evidence of carcinogenicity in animals. Inadequate evidence of carcinogenicity in humans.

Group C - Possible Human Carcinogen. Limited evidence of carcinogenicity in animals.

Group D - Not Classified. Inadequate evidence of carcinogenicity in animals.

Note :

For those compounds where inhalation criteria are not available, the oral criteria will not be used as the slope factor in evaluating the potential risk (USEPA, 1989a).

* : Integrated Risk Information System, 1989.

** : Health Effects Assessment Summary Tables - Second, Third and Fourth Quarters. USEPA, 1989.

ND : Not Determined (--) : Not Available

SECTION 5.0

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5.0 RISK CHARACTERIZATION

5.1 HEALTH-BASED APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Based upon current USEPA guidance (USEPA, 1989a) for preparation of a endangerment assessments, the potential adverse effects on human health must be assessed where possible by comparing chemical concentrations found in environmental media at or near the site and at receptor locations with applicable or relevant and appropriate requirements (ARARs) or other guidance that has been developed for the protection of human health or the environment. In this section, ARARs or other guidance are first identified for the chemical(s) of potential concern. Where chemical-specific or ambient ARARs are available for an environmental medium, they are compared with average and maximum concentrations observed in that medium at points of potential exposure. USEPA interim guidance on ARARs (USEPA, 1987) defines them as follows:

"Applicable requirements" is defined as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site. "Applicability" implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement.

"Relevant and appropriate requirements" is defined as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to a particular site.

The relevance and appropriateness of a requirement may be judged by comparing a number of factors, including the characteristics of the remedial action, the hazardous substances in question, or the physical circumstances of the site, with those addressed in the requirement. It is also helpful to look at the objective and origin of the requirement. For example, while RCRA regulations are not applicable to closing undisturbed hazardous waste in place, the RCRA regulation for closure by capping may be deemed relevant and appropriate.

A requirement that is judged to be relevant and appropriate must be complied with to the same degree as if it were applicable.

However, there is more discretion in this determination: it is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed if judged not to be relevant and appropriate in a given case.

Non-promulgated advisories or guidance documents issued by federal or state governments do not have the status of potential ARARs. However, they may be considered in determining the necessary level of cleanup for protection of health or the environment. Such guidance has been established as "To Be Considered" (TBC) criteria.

Only those ARARs, advisories or guidance that are ambient or chemical-specific requirements [i.e., those requirements which "set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants" (USEPA, 1987)], as opposed to ARARs which are classified as action-specific or locational requirements, are used in this endangerment assessment.

5.1.1 Soil ARARs

The Toxic Substances Control Act (TSCA), promulgated in 1976 and with an effective date of February 17, 1978, requires the regulation and disposal of all PCB's that have entered the environment if the source of contamination prior to the spill contained concentrations of 50 ppm or greater PCB's. Therefore, TSCA is considered applicable to the Hooker/Ruco site for the disposal of PCB-contaminated material with concentrations greater than 50 ppm.

Also under the TSCA is a spill policy for the cleanup of PCB's established by the USEPA, for which the effective date is May 4, 1988. The TSCA policy outlines the measures which USEPA considers to be adequate for the majority of situations where PCB contamination occurs during activities regulated under the TSCA. This policy does not apply to spills that occurred before the effective date of the policy or to actions being taken under environmental statutes other than TSCA (e.g., CERCLA) such as the Hooker/Ruco site. The cleanup levels stated in the TSCA spill cleanup policy are TBC's, but can be considered at the site in the absence of other Federal or State regulations.

The TSCA policy established requirements for cleaning spills in restricted access areas. The PCB spill area is classified as a restricted access area because it is more than 0.1 km (kilometer) from a residential or commercial area. The policy would require a cleanup level of 25 ppm PCB's and a deed restriction for industrial use.

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5.1.2 Groundwater ARARs

Although groundwater is not of concern in this EA, groundwater ARARs are provided for informational purposes.

Definitive federal maximum contaminant levels (MCLs) have not been established for PCBs in drinking water, however a concentration level of 0.5 ppb has been proposed as of May, 1989. Conversely, New York State Department of Environmental Conservation, in the Ambient Water Quality Standards and Guidance Values, has promulgated a groundwater Class GA standard of 0.1 ppb for drinking water (April, 1987). This standard is lowered to 0.001 ppb for drinking water Classes A, A-S, AA, and AA-S.

5.2 QUANTITATIVE RISK CHARACTERIZATION

To quantitatively assess the risks to human health associated with present and future land-use conditions, chronic average daily intakes (SIs) are estimated for each exposure pathway described in Section 3.4. SIs are expressed as the amount of a chemical an individual may be exposed to per unit body weight per day (mg/kg/day). An SI is averaged over a lifetime for carcinogens (USEPA, 1989a) and over the exposure period for non-carcinogens (USEPA, 1989a). As stated previously, PCBs are considered as potential carcinogen compounds only.

The estimated chronic daily intakes are subsequently combined with health effects criteria (cancer slope factors) to quantitatively estimate potential human health risks. For potential carcinogens, excess lifetime cancer risks are obtained by multiplying the SI for the contaminant under consideration by its cancer slope factor. USEPA has implemented actions under the Superfund program associated with total cancer risks ranging from 10^{-4} to 10^{-6} . This is respective of the incremental probability of developing cancer over a 75-year lifetime is 1 in 10,000 people or 1 in 1,000,000 people, respectively. Subsequent guidance (USEPA, 1989a) specifically state a target risk level of 10^{-6} .

Chronic daily intakes and excess lifetime cancer risks for Aroclor-1248 are presented for each of the selected exposure pathways in the following subsections.

5.2.1 Ingestion of Site Soil

Under the present and future-use scenario, it is assumed that site surface soil ingestion by site workers and trespassers may pose a potential human health risk. Calculation of the SI by this pathway is shown in Table 5-1, while Appendix B, Tables B-1, B-2, B-5, and B-6 display risk calculations.

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Present-Use

Exposure of site workers and trespassers to surface soil via ingestion resulted in risk above the target risk level (10^{-6}) for both the average and reasonable maximum exposure (RME) scenarios. Site worker ingestion of site surface soil resulted in the highest risks of 3.07×10^{-4} and 1.08×10^{-3} for average and RME exposure scenarios respectively.

Future-Use

Exposure of construction workers and residents to subsurface soil via ingestion resulted in risk above the target risk level (10^{-6}) for both the average and reasonable maximum exposure (RME) scenarios. Resident exposure of site subsurface soil showed the higher risk of the two scenarios, with 1.65×10^{-5} and 1.66×10^{-4} for average and RME exposure scenarios respectively.

5.2.2 Direct Contact with Site Soil

Under the present and future-use scenario, it is assumed that direct contact with site surface soil by site workers and trespassers may pose a potential human health risk. Calculation of the SI by this pathway is shown in Table 5-2, while Appendix B, Tables B-3, B-4, B-7 and B-8 display risk calculations.

Present-Use

Exposure of site workers and trespassers to surface soil via direct contact resulted in risk above the target risk level (10^{-6}) for both the average and reasonable maximum exposure scenarios. Site worker direct contact of site surface soil resulted in the highest risks of 2.16×10^{-4} and 7.18×10^{-3} for average and RME exposure scenarios, respectively.

Future-Use

Exposure of construction workers and residents to subsurface soil via ingestion resulted in risk above target risk level (10^{-6}) for both the average and reasonable maximum exposure scenarios. Resident exposure of site subsurface soil showed the higher risk of the two exposure scenarios, with 1.16×10^{-5} and 1.11×10^{-3} for average and RME exposure scenarios, respectively.

5.2.3 Inhalation of Suspended Site Soil

Under the present-use scenario, it is assumed that inhalation of suspended site soils by site workers and trespassers may pose a potential human risk. However, quantification of this risk may not be calculated due to lack of an inhalation slope factor. Therefore, chronic daily intake (CDI) is estimated and compared

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TABLE 5-1

HOOKER/RUCO SITE
CALCULATION OF SITE SPECIFIC INTAKE
RATES FOR AROCLOR - 1248

SOIL INGESTION EXPOSURE PATHWAY

Equation:

$$SI = \frac{(SC) (SI) (BF) (EF) (ED) (CF)}{(BW)}$$

Variables:

- SI = Site specific intake for soil contaminants (mg/kg-day)
- SC = Soil concentration (95% upper confidence limit of the geometric mean)
- BF = Bioavailability factor
- EF = Exposure frequency [days exposed (days/year)⁻¹]
- ED = Exposure duration (year/year)
- CF = Conversion factor
- BW = Body weight (kg)

Note: .

All variable assumptions may be found in Section 3.4.

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TABLE 5-2

HOOKER/RUCO SITE
CALCULATION OF SITE SPECIFIC INTAKE
RATES FOR AROCLOR - 1248

SOIL DIRECT CONTACT EXPOSURE PATHWAY

Equation:

$$SI = \frac{(SC) (SSA) (BF) (SD) (EF) (ED) (CF)}{(BW)}$$

Variables:

- SI = Site specific intake for soil contaminants (mg/kg - day)
- SC = Soil concentration (95% upper confidence limit of the geometric mean)
- BF = Bioavailability factor
- SD = Skin deposition (mg/cm²)
- EF = Exposure frequency [days exposed (days/year)⁻¹]
- ED = Exposure duration (year/year)
- CF = Conversion factor
- BW = Body weight (kg)

NOTE:

All variable assumptions may be found in Section 3.4.

TABLE 5-3

HOOKER/RUCO SITE
CALCULATION OF SITE SPECIFIC INTAKE
RATES FOR AROCLOR - 1248

SUSPENDED SOIL INHALATION EXPOSURE PATHWAY

Equation:

$$SI = \frac{(SC) (SSC) (EL) (IR) (BF) (EF) (ED) (CF)}{(BW)}$$

Variables:

- SI = Site specific intake for soil contaminants (mg/kg - day)
- SC = Soil concentration (95% upper confidence limit of the geometric mean)
- SSC = Suspend soil flux (calculated in Section 3.2.5)
- EL = Exposure length (hours/day)
- IR = Inhalation rate (m³/hour)
- BF = Bioavailability factor
- EF = Exposure frequency [days exposed (days/year)⁻¹]
- ED = Exposure duration (year/year)
- CF = Conversion factor
- BW = Body weight (kg)

NOTE:

All variable assumptions may be found in Section 3.4.

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against those for the ingestion and direct contact pathways. Calculation of the CDI is shown in Table 5-3, while Appendix B, Tables B-9 and B-10 display actual variables.

Present-Use

Exposure to site workers and trespassers to suspended site soils via inhalation resulted in average CDIs of 9.44×10^{-6} and 14.2×10^{-6} respectively. Under the RME scenario, CDIs resulted in 7.11×10^{-5} and 6.08×10^{-6} respectively. When contrasted against the total body intake of PCBs (ingestion + direct contact + inhalation), the average inhalation intake for site workers and trespassers is approximately 10% and 16% of the total amount. Under the RME scenario the inhalation intake body load is less; 4.6% and 8.5% respectively of the total amount.

5.3 ENVIRONMENTAL IMPACTS CHARACTERIZATION

This section addresses potential ecological impacts associated with Aroclor-1248 present in the PCB spill area surrounding the Pilot Plant on the Hooker/Ruco site. The approach used in this environmental assessment roughly parallels that used in the human health risk assessment. Initially, potentially exposed populations (receptors) are identified. The information on exposure and toxicity is then combined qualitatively to derive estimates of potential impacts of these populations.

5.3.1 Receptor Characterization

The Hooker/Ruco site is located in a heavily industrial section of Hicksville, New York. The site has been occupied by various chemical companies since 1945. In the area of the Pilot Plant, most of the undeveloped land is characterized by relatively flat ground comprised of dirt and a small mixture of grasses. Terrestrial wildlife in this area is non-existent, although some species of animals typical of field habitats in the northeast may be present on other portions of the site. Mammals may include small animals such as rats, mice, squirrels and rabbits. A variety of small regional birds such as sparrows or robins may also be present. No endangered or threatened species are known to occur in the area (EAI, 1983).

5.3.2 Potential Exposure and Estimation of Impacts

Plant exposure to the surface soils in the PCB spill area mainly will occur through root intake. Plants may also be exposed to groundwater, and therefore subsurface soil, if the roots extend to the water table. Since the groundwater on the Hooker/Ruco site is approximately 50 feet below the ground surface, this occurrence is not considered likely. Additionally, irrigation with groundwater is absent on-site. Due to this fact and that vegetation is extremely scarce in the PCB spill area, an environmental impacts assessment is not warranted.

Wildlife may be exposed to Aroclor-1248 in the surface soil by the following pathways:

- o ingestion of soil
- o Dermal absorption during direct contact with surface soil
- o ingestion of plants which have accumulated PCBs

PCBs are known to have high bioaccumulation factors and are typically insoluble; therefore these contaminants tend to residue in animal fat tissue if introduced. However, as stated above, vegetation is scarce in the PCB spill area. There is also no existing natural surface water body within 3 miles of the site (Ebasco, 1988). These conditions in combination with facility activities discourage the use of the area as an habitat. As stated in Section 3.2.4, Aroclor-1248 is not likely to migrate off-site. Additionally, threatened or endangered species are not known to exist in the area (EAI, 1983). The close proximity of Grumman Aerospace, Old Bethpage landfill and other industrial facilities nearby the Hooker/Ruco site, introduce unquantifiable uncertainty to a wildlife impact assessment due to the mobility of the organisms, particularly birds. Therefore, a wildlife impact assessment was not considered warranted.

SECTION 6.0

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6.0 UNCERTAINTIES IN ENDANGERMENT ASSESSMENT

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to a wide variety of uncertainties. In general, the main sources of uncertainty in an endangerment assessment are:

- o Environmental chemistry sampling and analysis
- o Fate and transport modeling
- o Exposure parameter estimation
- o Toxicological data and models

Each uncertainty is discussed individually in the following subsections.

6.1 ENVIRONMENTAL CHEMISTRY SAMPLING AND ANALYSIS

Uncertainty in environmental sampling arises in part from the potentially uneven distributions of chemicals in the media sampled. Typically, this problem is encountered more frequently in soil than in water or air, and is due to the heterogeneous nature of soil. The sampling results of the Hooker/Ruco site for example, suggest the presence of "hot spots". Subsequently uneven spatial distributions of chemicals in the media being sampled may result in over or under estimation of the risks in each individual area. Therefore, the larger the number of samples, the better the estimate to be made of the variation in the chemical concentration in an area.

Uncertainties in chemical analysis can stem from several sources including the errors inherent in analytical methods, or the characteristics of the matrix being sampled. For this EA, the analytical methods chosen are those of the USEPA CLP. Procedural or systematic error was minimized by subjecting the data to a strict laboratory quality control review and data validation process. Certain data were qualified as estimated (i.e., flagged with a "J" or "N") due to documented variations from the standard sample handling or analytical procedures. Risks calculated using qualified data contains greater uncertainties than those calculated with more precise values. Accordingly, use of conservative exposure scenarios and toxicity criteria, reduces the chances of underestimation of risk.

The analytical detection limits obtained during a sample analysis are also of concern. Although Aroclor-1248 was not detected in some locations, analytical detection limits may have been several times higher than reported concentrations or the CLP contract detection limits. Therefore, the levels at which these chemicals are present is uncertain. If chemicals of concern were present at levels below the detection limit, but above the levels of concern, exclusion of these chemicals from

the endangerment assessment would underestimate the risks associated with certain exposures. However, if chemical concentrations are below both the detection limit and the levels of concern, their exclusion would not significantly impact the risk estimates presented in this assessment.

6.2 FATE AND TRANSPORT MODELING

Modeling error can arise from the use of an inappropriate model or the use of an appropriate model with inappropriate parameter values or boundary conditions. Other uncertainties can stem from a lack of validation or verification of the model. In this endangerment assessment the use of modelling was limited and this only applies to groundwater transport and particulate suspension of Aroclor-1248. Another example of overestimation of potential risks was the use of currently measured concentrations to represent potential future concentrations although exposures to any future on-site residents. These exposure point concentrations do not, however, reflect reduction in concentrations over time due to migration and/or attenuation of contaminants.

6.3 EXPOSURE PARAMETERS ESTIMATION

There are many uncertainties in the parameters used in the exposure pathways evaluated in this endangerment assessment. These parameters are used to estimate CDIs, which are then combined with toxicological information to assess potential risks. For example, there is uncertainty in the estimates of how often, if at all, an individual would come into contact with the chemicals of concern (i.e., days/year exposed) and the period of time over which such exposures would occur. For the soil contact pathway, potential future exposures to residents on-site were assumed to occur 43 and 130 days/year, respectively, for 9 and 30 years for the average and reasonable maximum case. These assumptions are considered more likely to be conservative, and thus are more likely to yield risks which are overestimated.

Several standard USEPA assumptions are used throughout this assessment and include ingestion of two liters of water a day, 70 kg average body weight, and 75 year lifetime. These are assumed to represent average values of potential exposures. Risks for certain individuals within an exposed population may be higher or lower depending on their actual soil intakes, body weights and life span.

While values used in daily intake calculations such as body weight and soil intake were standardized values, estimate of the amount of chemicals entering the body by different routes of exposure have not been standardized. For example, published values for percent dermal absorption as high as 55 percent have been reported for contact with mouse skin in vitro (Smith and Lawton, 1981).

An additional source of uncertainty in the endangerment assessment is the assumption that the exposure concentration and all other exposure parameters would remain constant over the exposure period. However, depending on the source release mechanism(s), chemical constituents may increase or decrease in concentration over time.

Chemical constituent intake rates were also assumed to come solely from the medium being evaluated. In doing so, the contribution of other sources was not considered.

6.4 TOXICOLOGICAL DATA AND MODELS

There is a great deal of uncertainty in assessing the toxicity of Aroclor-1248 detected at the site. As recommended by EPA (1986), it was assumed that chemicals act additively on the human body. This approach assumes that there are no synergistic or antagonistic interactions among the involved chemicals, and that all chemicals have the same toxic end points and mechanisms of action. However, some chemicals interact during absorption and metabolism for example, and affect different target organs in the human body. Furthermore, some compounds may interact yielding new toxic compounds.

In general, there is uncertainty with respect to slope factors (SFs). This uncertainty results from the practice of extrapolating the results of carcinogenic effects from animal tests and relating results of from tests with high-dose exposures to low human dose exposures. For example, a $7.70 \text{ E}+00$ cancer potency factor is used for all PCBs. Because this value is based on the oral exposure to PCBs, it may not be representative for Aroclor-1248.

Health effects criteria are not available for all contaminants. Specifically, inhalation slope factors for PCB are not available, therefore were not quantitatively evaluated because of the lack of adequate toxicological data. This may result in underestimation of risks.

In summary, in light of the uncertainties described above this risk assessment should not be considered an absolute estimate of risks to human or environmental populations. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts.

SECTION 7.0

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7.0 PRELIMINARY SITE CLEANUP GOALS

Preliminary site cleanup goals are derived for the soils surrounding the Pilot Plant as they exhibit a human health risk under all exposure pathways. It must be emphasized that the goals developed here are preliminary, and are defined only at the request of USEPA and to serve as the basis for potential site remediation. Also, it must be understood that current guidance and SARA requirements for Remedial Investigation and Feasibility Studies give USEPA wide latitude in setting remedial goals, requiring only that they conform to Applicable, Relevant and Appropriate Requirements ("ARARs") and enforceable Federal and State standards and regulations and that they be "protective of human health and the environment". This latter requirement is often interpreted to mean that cancer risks should be reduced to within EPA's "target risk range" of 10^{-4} to 10^{-6} lifetime cancer risks. Cleanup goals presented in this report are based on a target risk level of 10^{-6} .

In the discussion that follow, preliminary cleanup goals will be defined by "back-calculation" from the baseline no-action health risks at the Hooker/Ruco site, as discussed in Section 5.4. The specific assumptions used to define the cleanup goals are:

- o Where specific chemicals have enforceable ARARs, the cleanup levels will be defined to conform to the appropriate standard. Subsequently, chemical cleanup levels for PCBs will conform to enforceable TSCA cleanup goals.
- o Risk-based cleanup goals will be set at levels of contamination which allow a residual cancer risk of 1×10^{-6} for a given contaminant, medium, and exposure pathway.
- o Cleanup goals are calculated using the RME scenario which incorporates RME exposure assumptions and maximum concentrations. Goals are calculated for contaminants where the probable worst-case scenario yields a cancer risk of greater than 1×10^{-6} .
- o Cleanup goals are set as if some type of removal or treatment alternative will be selected.

Soil, the only site media to be evaluated in this endangerment assessment, has been found to exceed ARARs and exhibit health risks above the target risk level of 10^{-6} under all exposure scenarios. A risk based cleanup level of 0.37 ppm was calculated based on the site worker RME scenario and a target risk level of 10^{-6} . This scenario, although conservative, is considered realistic for the Hooker/Ruco site. Similarly, a risk based cleanup level was calculated based on the resident RME scenario and a target risk level of 10^{-6} , and was determined to be 0.56 ppm.

As requested by Region II of the USEPA, risk levels for the cleanup goals of 2 ppm, 10 ppm and 25 ppm were determined. Using the back calculation of above, the following risk levels were obtained:

<u>Cleanup Goal</u>	<u>Site Worker RME Scenario Risk Level</u>	<u>Resident RME Scenario Risk Level</u>
2 ppm	5.4×10^{-6}	3.6×10^{-6}
10 ppm	2.7×10^{-5}	1.8×10^{-5}
25 ppm	6.8×10^{-5}	4.5×10^{-5}

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SECTION 8.0

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8.0 SUMMARY OF ENDANGERMENT ASSESSMENT

In October 1984, the United States Environmental Protection Agency (USEPA) placed the Hooker Chemical/Ruco Polymer Corporation site (Hooker/Ruco) located in Hicksville, New York on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program. The site is currently classified as an enforcement lead site for which potentially responsible parties (PRPs) are conducting a Remedial Investigation/Feasibility Study (RI/FS). The PRPs for the site have retained the consulting firm Leggette, Brashears and Graham, Inc. (LBG) to perform a detailed RI/FS.

This endangerment assessment (EA) of the polychlorinated biphenyl (PCB) spill area soils surrounding the Pilot Plant on the Hooker/Ruco site was prepared at the request of Region II of the USEPA under the ARCS II Superfund Contract. It has been conducted independently of the PRP's efforts, but relies on the LBG RI report (April, 1990) and Focused Feasibility Study (FFS) (June, 1990) as the primary sources of information concerning conditions at the site. In addition, it is the intent of this EA to address the potential human health and environmental impacts associated with the Hooker/Ruco site under the no-action alternative, that is, in the absence of remedial (corrective) action as required under Section 300.68 (f)(v) of the National Contingency Plan.

Aroclor-1248 was selected by USEPA Region II to be the solitary contaminant of concern. Therefore, the focus of this EA was the health hazard posed by Aroclor-1248 in the soils surrounding the Pilot Plant. Data was extracted from the LBG RI report (April, 1990) and the FFS report (June, 1990). A total of 158 samples were tabulated. Contamination was found to range from 0.1 to 23,000 ppm, with an upper 95% confidence limit (CI) for surface soils (0 to 3 feet depth) of 2188 ppm and an upper 95% CI for subsurface soils (greater than 3 foot depth) of 692 ppm. A total of 74 samples exceeded a level of 10 ppm.

Upon the determination of Aroclor-1248 as the site contaminant of concern, environmental fate and transport of this chemical was then considered to assist in the evaluation and quantification of human health risks resulting from site contamination. PCBs in general were determined to exhibit low water solubilities and a high affinity to the particulate phase. In addition to these physical characteristics, a screening level model was employed to determine water-borne transport of Aroclor-1248 in the soils surrounding the Pilot Plant to the recharge basin. A supplement to this model was further evaluation to determine the amount of time required for PCBs, when deposited in the groundwater, to transport off-site. Based on these calculations it was determined that PCBs have

migrated via surface water runoff to the recharge basin, however approximately 14,000 years would pass before this contaminant would migrate off-site via groundwater transport.

For the quantitative assessment of risks, exposure estimates were combined with the health criteria for the selected chemicals of potential concern to estimate potential risks to human health. For exposure, risks are estimated for an average and a reasonable maximum exposure (RME) scenario. The average case combines the average case exposure estimated with generally upper-bound cancer potency factors and conservatively derived reference doses. This average case is intended to represent the exposure of a typical individual; however, use of conservative health criteria may result in an overestimation of risk even for the average case. The RME scenario combines the reasonable maximum exposure estimates to represent a conservative upper bound on the potential risks. Although this worst-case scenario possibly can occur, the likelihood is extremely small due to the unlikely combination of many conservative assumptions used.

Three exposure pathways were evaluated under the present and future-use scenarios. These exposure pathways are as follows:

- o Ingestion of surface and subsurface soil
- o Direct contact with surface and subsurface soil
- o Inhalation of suspended site soil

Volatilization of PCBs were not evaluated under the present or future-use scenarios after a screening level model indicated minimal amounts of volatile flux. Inhalation of suspended site soil was also not evaluated for the future-use scenario as it was considered under the present-use scenario at higher concentrations and that inhalation cancer slope factors were not available.

The summary results of the endangerment assessment are presented in Table 8-1. It can be seen from this table that a target risk level of 10^{-6} (USEPA, 1989a) was exceeded under all exposure scenarios, the highest risk being exhibited by site workers. For the inhalation of suspended site soil pathway, chronic daily intakes were determined in the absence of inhalation cancer slope factors to assess the body load of PCBs. Subsequent body load ranged from 4.6% to 16% of the total contaminant intake for the site worker and trespasser scenarios.

Using the RME exposure pathway for site worker and a target risk level of 10^{-6} , a risk based cleanup level of 0.37 ppm was calculated. Similarly, a risk based cleanup level was calculated based on the resident RME scenario and a target risk level of 10^{-6} , and was determined to be 0.56 ppm. At the request of Region II of the USEPA, risk levels for the cleanup goals of 2 ppm, 10 ppm, and 25 ppm were determined for both scenarios and the following risk levels were obtained:

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TABLE 8 - 1
Hooker/Ruco Site
SUMMATION OF RISKS POSED BY AROCLOR-1248

PRESENT-USE SCENARIO

PATHWAY :	SITE WORKERS		TRESPASSERS	
	<u>Average Cancer Risk</u>	<u>Reasonable Maximum Cancer Risk</u>	<u>Average Cancer Risk</u>	<u>Reasonable Maximum Cancer Risk</u>
Ingestion of Soil	2.20E-04	7.71E-04	6.59E-05	2.64E-04
Direct Contact with Soil	1.54E-04	5.14E-03	3.70E-05	7.02E-04
Total Cancer Risk	<u>3.74E-04</u>	<u>5.91E-03</u>	<u>1.03E-04</u>	<u>9.66E-04</u>

FUTURE-USE SCENARIO

PATHWAY :	CONSTRUCTION WORKERS		RESIDENTS	
	<u>Average Cancer Risk</u>	<u>Reasonable Maximum Cancer Risk</u>	<u>Average Cancer Risk</u>	<u>Reasonable Maximum Cancer Risk</u>
Ingestion of Soil	7.72E-06	2.44E-05	1.61E-05	1.63E-04
Direct Contact with Soil	5.42E-06	1.62E-04	1.13E-05	1.08E-03
Total Cancer Risk	<u>1.31E-05</u>	<u>1.86E-04</u>	<u>2.74E-05</u>	<u>1.24E-03</u>

NOTE :

Target Risk Level = 10E-06

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<u>Cleanup Goal</u>	Site Worker RME Scenario <u>Risk Level</u>	Resident RME Scenario <u>Risk Level</u>
2 ppm	5.4×10^{-6}	3.6×10^{-6}
10 ppm	2.7×10^{-5}	1.8×10^{-5}
25 ppm	6.8×10^{-5}	4.5×10^{-5}

Numerous sources for uncertainty in this EPA was identified, and it was stated that the estimated risks should not be considered as precise numbers.

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Hooker/Ruco Site Tabulation of LBG Data

Location : Sampling Range : Aroclor-1248 Concentration:
 (feet) (ppm)

AA	1.1		19.00
BB	0.9		14.50
CC	1.0		15.80
DD	1.0		12.90
EE	1.0		10.40
EE	2.4		0.20
FF	0.9		2.50
FFF-1	0.6	- 1.0	25.00
FFF-2	1.6	- 3.0	1.50
FFF-3	3.0	- 4.5	ND 0.1
FFF-4	4.5	- 6.0	ND 0.1
GG-1	1.0		192.70
GG-2	2.2		11.30
GG-3	2.6		26.00
H	0.7		23.00
HH-1	1.1		562.00
HH-2	2.3		105.30
II	0.9		4.30
J	1.0		59.00
JJ-1	1.0		21.50
JJ-2	2.5		16.00
K-1	0.9		61.00
K-2	1.7	- 1.8	0.20
KK	0.9		0.70
L	1.1		0.70
M	1.7		15.00
MB	0.6		4.90
MM-1	0.6		8.30
MM-2	0.9		7.40
N	0.9		8.00
O	1.9		0.80
OO	1.0		25.10
OO	3.0		6.60
P	1.0		4.40
PP-1	1.0		36.40
PP-2	2.9		10.40
Q1	0.8		14.00

APPENDIX A

Hooker/Ruco Site Tabulation of LBG Data

SOURCE : LBG FFS (1989) , PLATE 2 ; LBG RI (1990)

<u>Location :</u>	<u>Sampling Range :</u> (feet)	<u>Aroclor-1248 Concentration:</u> (ppm)
Q2A/Q2B	0.7	39.00
Q3-1	0.6	76.00
Q3-2	1.7	7.80
Q4	0.9	28.00
Q5	0.5	12.00
Q6-1	1.0	1060.00
Q6-2	1.5	45.00
Q6-3	3.0	6.60
QQ-1	1.0	46.00
QQ-2	3.2	1.40
R1A	0.8	24.00
R1B	1.3	47.00
R2	2.6	4.10
R2A-1	1.0	490.00
R2A-2	1.7	68.30
R2A-3	1.9	2.30
R3	1.1	13.00
R4-1	0.7	46.00
R4-2	1.8	4.80
RO-1	1.1	2900.00
RO-2	1.5	240.00
RO-3	2.9	9.60
S-1	0.5 - 1.0	900.00
S-1B	0.0	14.00
S-2	0.8	0.80
S-2	1.5 - 3.0	310.00
S-3	3.0 - 4.5	1.40
S-4	4.5 - 6.0	0.40
SB-1A	0.0	29.00
SU-1A	1.0	0.20
SU1-2	2.0	92.10
SU1-3	6.0	0.20
SU1-4	8.4	0.10
SU1-5	10.4	0.10
SU2-1	1.7	176.50
SU2-2	2.0	49.70
SU2-3	4.0	1.10
SU2-4	6.0	1.20

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APPENDIX A

Hooker/Ruco Site Tabulation of LBG Data

SOURCE : LBG FFS (1989) , PLATE 2 ; LBG RI (1990)

<u>Location :</u>	<u>Sampling Range :</u> (feet)	<u>Aroclor-1248 Concentration:</u> (ppm)
SU2-5	10.4	0.20
SU3-1	2.0	94.80
SU3-2	6.5	49.70
SU3-3	8.5	5.20
SU3-4	10.5	0.80
TB-7B	2.7	440.00
TB-8	3.9	2.30
TB-34	1.0 - 3.0	22.00
TB-34	3.0 - 5.0	11.00
TB-35	1.0 - 3.0	2.80
TB-35	3.0 - 5.0	ND 0.2
TB-36	1.0 - 3.0	2100.00
TB-36	3.0 - 5.0	410.00
TB-37	7.0 - 9.0	ND 0.2
TB-37	9.0 - 11.0	ND 0.2
TB-38	9.0 - 11.0	ND 0.2
TB-38	11.0 - 13.0	ND 0.2
U-1	0.6 - 1.0	1800.00
U-2	1.5 - 3.0	0.20
U-3	3.0 - 4.5	ND 0.1
U-4	4.5 - 6.0	ND 0.1
V-1	1.0	20000.00
V-2	1.0 - 2.5	2200.00
V-3	2.5 - 4.0	ND 50
V-4	4.0 - 5.5	3.30
V-5	5.5 - 7.0	13.00
V-6	7.0 - 8.5	7.00
V-7	8.5 - 10.0	21.00
W-1	0.8 - 1.3	50.00
W-2	1.7 - 3.2	5.00
W-3	3.0 - 4.5	0.30
X-1	0.5 - 1.0	23000.00
X-2	1.0 - 2.5	1300.00
X-3	2.5 - 4.0	21.00
X-4	4.0 - 5.5	54.00
X-5	5.5 - 7.0	8.60
X-6	7.0 - 8.5	18.00
X-7	8.5 - 10.0	10.00

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APPENDIX A

Hooker/Ruco Site Tabulation of LBG Data

SOURCE : LBG FFS (1989) , PLATE 2 ; LBG RI (1990)

<u>Location :</u>	<u>Sampling Range :</u> (feet)	<u>Aroclor-1248 Concentration:</u> (ppm)
XY	1.5	430.00
Y-1	1.0 - 2.5	11000.00
Y-2	2.5 - 4.0	500.00
Y-3	4.0 - 5.5	30.00
Y-4	5.5 - 7.0	11.00
Y-5	7.0 - 8.5	7.20
Y-6	8.5 - 10.0	7.00
Z-1	0.5 - 2.0	22000.00
Z-2	2.0 - 3.5	7300.00
Z-3	3.5 - 5.0	1900.00
Z-4	5.0 - 6.5	87.00
Z-5	6.5 - 8.5	28.00
Z-6	8.5 - 10.0	35.00
ZA	1.0	1.00
ZB	1.0	9.10
ZC	1.0	10.90
ZD	1.0	8.30
ZE	1.0	2.10
ZF	1.2	0.20
ZG	1.0	5.40
ZH	1.0	4.90
ZI	1.0	2.60
ZJ	1.0	1.90
ZK	1.0	5.10

Dirt Piles

DP-1	0.0	0.70
DP-2	0.0	24.00
DP-3	0.0	100.00
DP-4	0.0	170.00
DP-5	0.0	62.00
DP-6	0.0	140.00
DP-7	0.0	420.00
DP-8	0.0	230.00
DP-9	0.0	72.00
DP-10	0.0	58.00
DP-11	0.0	140.00

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APPENDIX A

Hooker/Ruco Site
Tabulation of LBG Data

SOURCE : LBG FFS (1989) , PLATE 2 ; LBG RI (1990)

<u>Location :</u>	<u>Sampling Range :</u> (feet)	<u>Aroclor-1248 Concentration:</u> (ppm)
DP-12	0.0	120.00
DP-13	0.0	23.00
DP-14	0.0	100.00
DP-A	0.0	50.00
DP-B	0.0	37.00
DP-C	0.0	60.00
DP-D	0.0	240.00
DP-E	0.0	67.00
DP-F	0.0	92.00
DP-G	0.0	69.00

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APPENDIX B

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TABLE B - 1
Wooker/Ruco Site
Surface Soil Ingestion Present-Use Pathway Model
- RISKS TO SITE WORKERS

CARCINOGENS - AVERAGE SURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{Chronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^{-6} \text{ mg}} \\ \text{Chronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 100 \text{ mg/day} \times 0.15 \times \frac{1}{70 \text{ kg}} \times \frac{185 \text{ days}}{365 \text{ days}} \times \frac{9 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^{-6} \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	2.19E+03	100	0.15	70	5.07E-01	1.20E-01	2.85E-05	7.70E+00	2.20E-04

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{Chronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^{-6} \text{ mg}} \\ \text{Chronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 100 \text{ mg/day} \times 0.15 \times \frac{1}{70 \text{ kg}} \times \frac{195 \text{ days}}{365 \text{ days}} \times \frac{30 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^{-6} \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	2.19E+03	100	0.15	70	5.34E-01	4.00E-01	1.00E-04	7.70E+00	7.71E-04

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TABLE B - 2
 Hooker/Ruco Site
 Surface Soil Ingestion Present-Use Pathway Model
RISKS TO TRESSPASSERS

CARCINOGENS - AVERAGE SURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{hronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \\ \text{hronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 100 \text{ mg/day} \times 0.15 \times \frac{1}{56 \text{ kg}} \times \frac{80 \text{ days}}{365 \text{ days}} \times \frac{5 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	2.19E+03	100	0.15	56	2.19E-01	6.67E-02	8.56E-06	7.70E+00	6.59E-05

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{hronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \\ \text{hronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 200 \text{ mg/day} \times 0.15 \times \frac{1}{56 \text{ kg}} \times \frac{160 \text{ days}}{365 \text{ days}} \times \frac{5 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	2.19E+03	200	0.15	56	4.38E-01	6.67E-02	3.43E-05	7.70E+00	2.64E-04

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TABLE B - 3
 Hooker/Ruco Site
 Surface Soil Direct Contact Present-Use Pathway Model
RISKS TO SITE WORKERS

CARCINOGENS - AVERAGE SURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	$\frac{1}{70 \text{ kg}}$ Body Wt	X	$\frac{\text{Days Exposed}}{\text{Days/Year}}$	X	$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$	X	$\frac{1 \text{ kg}}{10^6 \text{ mg}}$			
Chronic Daily Intake (mg/kg-day)		mg/kg	X	3510 cm ²	X	6.00E-03	X	0.5 mg/cm ²	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{185 \text{ days}}{365 \text{ days}}$	X	$\frac{9 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1 \text{ kg}}{10^6 \text{ mg}}$			
Group	Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		Days Exposed Days/Year		Years Exposed Years Lifetime		CDI	SF	RISK SF*CDI	
Adults	AROCOR-1248	2.19E+03		3.51E+03		6.00E-03		0.5		70		5.07E-01		1.20E-01		2.00E-05	7.70E+00	1.54E-04	

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	$\frac{1}{70 \text{ kg}}$ Body Wt	X	$\frac{\text{Days Exposed}}{\text{Days/Year}}$	X	$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$	X	$\frac{1 \text{ kg}}{10^6 \text{ mg}}$			
Chronic Daily Intake (mg/kg-day)		mg/kg	X	8320 cm ²	X	1.20E-02	X	1.0 mg/cm ²	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{195 \text{ days}}{365 \text{ days}}$	X	$\frac{30 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1 \text{ kg}}{10^6 \text{ mg}}$			
Group	Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		Days Exposed Days/Year		Years Exposed Years Lifetime		CDI	SF	RISK SF*CDI	
Adults	AROCOR-1248	2.19E+03		8.32E+03		1.20E-02		1.0		70		5.34E-01		4.00E-01		6.67E-04	7.70E+00	5.14E-03	

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TABLE B - 4
 Hooker/Ruco Site
 Surface Soil Direct Contact Present-Use Pathway Model
RISKS TO TRESPASSERS

CARCINOGENS - AVERAGE SURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil X	Skin	X Bioavail.	X	Skin	X	<u>1</u>	X	<u>Days Exposed</u>	X	<u>Years Exposed</u>	X	<u>1 kg</u>
		Conc	Surface Area	Factor		Deposition		Body Wt		Days/Year		Years Lifetime		10 ⁻⁶ mg
Chronic Daily Intake (mg/kg-day)		mg/kg	X 3510 cm ²	X 6.00E-03	X	0.5 mg/cm ²	X	<u>1</u>	X	<u>80 days</u>	X	<u>5 yrs</u>	X	<u>1 kg</u>
								70 kg		365 days		75 yrs		10 ⁻⁶ mg
Group	Compound	Soil Conc (mg/kg)	Skin Surface Area (cm ²)	Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		<u>Days Exposed</u> Days/Year		<u>Years Exposed</u> Years Lifetime		RISK SF*CDI
Adults	AROCLOR-1248	2.19E+03	3.51E+03	6.00E-03		0.5		70		2.19E-01		6.67E-02		4.81E-06 7.70E+00 3.70E-05

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil X	Skin	X Bioavail.	X	Skin	X	<u>1</u>	X	<u>Days Exposed</u>	X	<u>Years Exposed</u>	X	<u>1 kg</u>
		Conc	Surface Area	Factor		Deposition		Body Wt		Days/Year		Years Lifetime		10 ⁻⁶ mg
Chronic Daily Intake (mg/kg-day)		mg/kg	X 8320 cm ²	X 1.20E-02	X	1.0 mg/cm ²	X	<u>1</u>	X	<u>160 days</u>	X	<u>5 yrs</u>	X	<u>1 kg</u>
								70 kg		365 days		75 yrs		10 ⁻⁶ mg
Group	Compound	Soil Conc (mg/kg)	Skin Surface Area (cm ²)	Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		<u>Days Exposed</u> Days/Year		<u>Years Exposed</u> Years Lifetime		RISK SF*CDI
Adults	AROCLOR-1248	2.19E+03	8.32E+03	1.20E-02		1.0		70		4.38E-01		6.67E-02		9.12E-05 7.70E+00 7.02E-04

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TABLE B - 5
 Hooker/Ruco Site
 Subsurface Soil Ingestion Future-Use Pathway Model
RISKS TO CONSTRUCTION WORKERS

CARCINOGENS - AVERAGE SUBSURFACE SOIL INGESTION EXPOSURE

Chronic Daily Intake (mg/kg-day)	=	Soil Conc	X	Soil Intake	X	Bioavail. Factor	X	$\frac{1}{\text{Body Wt.}}$	X	$\frac{\text{Days Exposed}}{\text{Days/Year}}$	X	$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$	X	$\frac{1\text{kg}}{10^6 \text{ mg}}$		
Chronic Daily Intake (mg/kg-day)	=	mg/kg	X	100 mg/day	X	0.15	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{185 \text{ days}}{365 \text{ days}}$	X	$\frac{1 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1\text{kg}}{10^6 \text{ mg}}$		
Compound		Soil Conc (mg/kg)		Intake (mg/day)		Bio- availability Factor		Body Weight (kg)		<u>Days Exposed</u> Days/Yr		<u>Years Exposed</u> Years Lifetime		CDI	SF	RISK SF*CDI
AROCLOL-1248		6.92E+02		100		0.15		70		5.07E-01		1.33E-02		1.00E-06	7.70E+00	7.72E-06

CARCINOGENS - REASONABLE MAXIMUM SUBSURFACE SOIL INGESTION EXPOSURE

Chronic Daily Intake (mg/kg-day)	=	Soil Conc	X	Soil Intake	X	Bioavail. Factor	X	$\frac{1}{\text{Body Wt.}}$	X	$\frac{\text{Days Exposed}}{\text{Days/Year}}$	X	$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$	X	$\frac{1\text{kg}}{10^6 \text{ mg}}$		
Chronic Daily Intake (mg/kg-day)	=	mg/kg	X	100 mg/day	X	0.15	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{195 \text{ days}}{365 \text{ days}}$	X	$\frac{3 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1\text{kg}}{10^6 \text{ mg}}$		
Compound		Soil Conc (mg/kg)		Intake (mg/day)		Bio- availability Factor		Body Weight (kg)		<u>Days Exposed</u> Days/Yr		<u>Years Exposed</u> Years Lifetime		CDI	SF	RISK SF*CDI
AROCLOL-1248		6.92E+02		100		0.15		70		5.34E-01		4.00E-02		3.17E-06	7.70E+00	2.44E-05

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TABLE B - 6
Hooker/Ruco Site
Subsurface Soil Ingestion Future-Use Pathway Model
* RISKS TO RESIDENTS

CARCINOGENS - AVERAGE SUBSURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{Chronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \\ \text{Chronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 100 \text{ mg/day} \times 0.15 \times \frac{1}{70 \text{ kg}} \times \frac{43 \text{ days}}{365 \text{ days}} \times \frac{9 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	6.92E+02	100	0.15	70	1.18E-01	1.20E-01	2.10E-06	7.70E+00	1.61E-05

CARCINOGENS - REASONABLE MAXIMUM SUBSURFACE SOIL INGESTION EXPOSURE

$$\begin{aligned} \text{Chronic Daily Intake (mg/kg-day)} &= \text{Soil Conc} \times \text{Soil Intake} \times \text{Bioavail. Factor} \times \frac{1}{\text{Body Wt.}} \times \frac{\text{Days Exposed}}{\text{Days/Year}} \times \frac{\text{Years Exposed}}{\text{Years Lifetime}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \\ \text{Chronic Daily Intake (mg/kg-day)} &= \text{mg/kg} \times 100 \text{ mg/day} \times 0.15 \times \frac{1}{70 \text{ kg}} \times \frac{130 \text{ days}}{365 \text{ days}} \times \frac{30 \text{ yrs}}{75 \text{ yrs}} \times \frac{1\text{kg}}{10^6 \text{ mg}} \end{aligned}$$

Group	Compound	Soil Conc. (mg/kg)	Intake (mg/day)	Bio-availability Factor	Body Weight (kg)	Days Exposed Days/Year	Years Exposed Years Lifetime	CDI	SF	RISK SF*CDI
Adults	AROCOR-1248	6.92E+02	100	0.15	70	3.56E-01	4.00E-01	2.11E-05	7.70E+00	1.63E-04

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TABLE B - 7
Hooker/Ruco Site
Subsurface Soil Direct Contact Future-Use Pathway Model
RISKS TO CONSTRUCTION WORKERS

CARCINOGENS - AVERAGE SUBSURFACE SOIL DIRECT CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)	= Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	1 Body Wt	X	Days Exposed Days/Year	X	Years Exposed Years Lifetime	X	1 kg 10 ⁻⁶ mg
Chronic Daily Intake (mg/kg-day)	= mg/kg	X	3510 cm ²	X	6.00E-03	X	0.5 mg/cm ²	X	1 70 kg	X	185 days 365 days	X	1 yrs 75 yrs	X	1 kg 10 ⁻⁶ mg
Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio- availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		Days Exposed Days/Yr		Years Exposed Years Lifetime		RISK SF*CDI
AROCOR-1248	6.92E+02		3510		6.00E-03		0.50		70		5.07E-01		1.33E-02		7.03E-07 7.70E+00 5.42E-06

CARCINOGENS - MAXIMUM SUBSURFACE SOIL DIRECT CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)	= Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	1 Body Wt	X	Days Exposed Days/Year	X	Years Exposed Years Lifetime	X	1 kg 10 ⁻⁶ mg
Chronic Daily Intake (mg/kg-day)	= mg/kg	X	8320 cm ²	X	1.20E-02	X	1.0 mg/cm ²	X	1 70 kg	X	195 days 365 days	X	3 yrs 75 yrs	X	1 kg 10 ⁻⁶ mg
Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio- availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		Days Exposed Days/Yr		Years Exposed Years Lifetime		RISK SF*CDI
AROCOR-1248	6.92E+02		8320		1.20E-02		1.00		70		5.34E-01		4.00E-02		2.11E-05 7.70E+00 1.62E-04

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TABLE B - 8
 Hooker/Ruco Site
 Subsurface Soil Direct Contact Future-Use Pathway Model
RISKS TO RESIDENTS

CARCINOGENS - AVERAGE SUBSURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{\text{Days Exposed}}{\text{Days/Year}}$	X	$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$	X	$\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$			
Chronic Daily Intake (mg/kg-day)		mg/kg	X	3510 cm ²	X	6.00E-03	X	0.5 mg/cm ²	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{43 \text{ days}}{365 \text{ days}}$	X	$\frac{9 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$			
Group	Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		$\frac{\text{Days Exposed}}{\text{Days/Year}}$		$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$		CDI	SF	RISK SF*CDI	
Adults	AROCOR-1248	6.92E+02		3.51E+03		6.00E-03		0.5		70		1.18E-01		1.20E-01		1.47E-06	7.70E+00	1.13E-05	

CARCINOGENS - REASONABLE MAXIMUM SUBSURFACE SOIL CONTACT EXPOSURE

Chronic Daily Intake (mg/kg-day)		Soil Conc	X	Skin Surface Area	X	Bioavail. Factor	X	Skin Deposition	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{\text{Days Exposed}}{365 \text{ days}}$	X	$\frac{\text{Years Exposed}}{75 \text{ yrs}}$	X	$\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$			
Chronic Daily Intake (mg/kg-day)		mg/kg	X	8320 cm ²	X	1.20E-02	X	1.0 mg/cm ²	X	$\frac{1}{70 \text{ kg}}$	X	$\frac{130 \text{ days}}{365 \text{ days}}$	X	$\frac{30 \text{ yrs}}{75 \text{ yrs}}$	X	$\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$			
Group	Compound	Soil Conc (mg/kg)		Skin Surface Area (cm ²)		Bio-availability Factor		Skin Deposition (mg/cm ²)		Body Weight (kg)		$\frac{\text{Days Exposed}}{\text{Days/Year}}$		$\frac{\text{Years Exposed}}{\text{Years Lifetime}}$		CDI	SF	RISK SF*CDI	
Adults	AROCOR-1248	6.92E+02		8.32E+03		1.20E-02		1.0		70		3.56E-01		4.00E-01		1.41E-04	7.70E+00	1.08E-03	

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Hooker/Ruco Site
Surface Soil Inhalation Present-Use Pathway Model
DAILY INTAKE OF SITE WORKERS

CARCINOGENS - AVERAGE SURFACE SOIL INHALATION EXPOSURE

Chronic Daily Intake (mg/kg-day)	= Soil Conc	X Susp Soil Conc	X Length of Exp	X Inhalation Rate	X Bioavail. Factor	X $\frac{1}{\text{Body Wt}}$	X <u>Days Exposed</u> Days/Year	X <u>Years Exposed</u> Years Lifetime	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Chronic Daily Intake (mg/kg-day)	= mg/kg	X 2.76E+00 mg/m ³	X 8 hrs/day	X 1.4 m ³ /hr	X 0.15	X $\frac{1}{70 \text{ kg}}$	X <u>185 days</u> 365 days	X <u>9 yrs</u> 70 yrs	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
<u>Compound</u>	<u>Soil Conc (mg/kg)</u>	<u>Susp Soil Conc (mg/m³)</u>	<u>Length of Exp (hrs/day)</u>	<u>Inhalation Rate (m³/hr)</u>	<u>Bio- availability Factor</u>	<u>Body Weight (kg)</u>	<u>Days Exposed</u> Days/Yr	<u>Years Exposed</u> Years Lifetime	<u>CDI</u>
AROCOR-1248	2.19E+03	2.76E+00	8.0	1.4	0.15	70	5.07E-01	1.29E-01	9.44E-06

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL INHALATION EXPOSURE

Chronic Daily Intake (mg/kg-day)	= Soil Conc	X Susp Soil Conc	X Length of Exp	X Inhalation Rate	X Bioavail. Factor	X $\frac{1}{\text{Body Wt}}$	X <u>Days Exposed</u> Days/Year	X <u>Years Exposed</u> Years Lifetime	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Chronic Daily Intake (mg/kg-day)	= mg/kg	X 2.76E+00 mg/m ³	X 8 hrs/day	X 3.0 m ³ /hr	X 0.15	X $\frac{1}{70 \text{ kg}}$	X <u>195 days</u> 365 days	X <u>30 yrs</u> 70 yrs	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
<u>Compound</u>	<u>Soil Conc (mg/kg)</u>	<u>Susp Soil Conc (mg/m³)</u>	<u>Length of Exp (hrs/day)</u>	<u>Inhalation Rate (m³/hr)</u>	<u>Bio- availability Factor</u>	<u>Body Weight (kg)</u>	<u>Days Exposed</u> Days/Yr	<u>Years Exposed</u> Years Lifetime	<u>CDI</u>
AROCOR-1248	2.19E+03	2.76E+00	8.0	3.0	0.15	70	5.34E-01	4.29E-01	7.11E-05

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TABLE B - 10
 Hooker/Ruco Site
 Surface Soil Inhalation Present-Use Pathway Model
DAILY INTAKE OF TRESPASSERS

CARCINOGENS - AVERAGE SURFACE SOIL INHALATION EXPOSURE

Chronic Daily Inta (mg/kg-day)	= Soil Conc	X Susp Soil Conc	X Length of Exp	X Inhalation Rate	X Bioavail. Factor	X $\frac{1}{56 \text{ kg}}$ Body Wt	X $\frac{\text{Days Exposed}}{365 \text{ days}}$ Days/Year	X $\frac{\text{Years Exposed}}{70 \text{ yrs}}$ Years Lifetime	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Chronic Daily Inta (mg/kg-day)	= mg/kg	X 2.76E+00 mg/m ³	X 4 hrs/day	X 1.4 m ³ /hr	X 0.15	X $\frac{1}{56 \text{ kg}}$	X $\frac{80 \text{ days}}{365 \text{ days}}$	X $\frac{5 \text{ yrs}}{70 \text{ yrs}}$	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Compound	Soil Conc (mg/kg)	Susp Soil Conc (mg/m ³)	Length of Exp (hrs/day)	Inhalation Rate (m ³ /hr)	Bio- availability Factor	Body Weight (kg)	Days Exposed Days/Yr	Years Exposed Years Lifetime	CDI
AROCLOL-1248	2.19E+03	2.76E+00	4.0	1.4	0.15	56	2.19E-01	7.14E-02	1.42E-06

CARCINOGENS - REASONABLE MAXIMUM SURFACE SOIL INHALATION EXPOSURE

Chronic Daily Inta (mg/kg-day)	= Soil Conc	X Susp Soil Conc	X Length of Exp	X Inhalation Rate	X Bioavail. Factor	X $\frac{1}{56 \text{ kg}}$ Body Wt	X $\frac{\text{Days Exposed}}{365 \text{ days}}$ Days/Year	X $\frac{\text{Years Exposed}}{70 \text{ yrs}}$ Years Lifetime	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Chronic Daily Inta (mg/kg-day)	= mg/kg	X 2.76E+00 mg/m ³	X 4 hrs/day	X 3.0 m ³ /hr	X 0.15	X $\frac{1}{56 \text{ kg}}$	X $\frac{160 \text{ days}}{365 \text{ days}}$	X $\frac{5 \text{ yrs}}{70 \text{ yrs}}$	X $\frac{1 \text{ kg}}{10^{-6} \text{ mg}}$
Compound	Soil Conc (mg/kg)	Susp Soil Conc (mg/m ³)	Length of Exp (hrs/day)	Inhalation Rate (m ³ /hr)	Bio- availability Factor	Body Weight (kg)	Days Exposed Days/Yr	Years Exposed Years Lifetime	CDI
AROCLOL-1248	2.19E+03	2.76E+00	4.0	3.0	0.15	56	4.38E-01	7.14E-02	6.08E-06

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